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ELEMENTARY SCIENCE CONCEPTS;
PICTORIAL vs. READING TESTS

by

© JANET WAINBERG

A THESIS

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled ELEMENTARY SCIENCE CONCEPTS: PICTORIAL vs. READING TESTS submitted by Janet Wainberg in partial fulfilment of the requirements for the degree of Master of Education.

ABSTRACT

Evaluation, as an integral part of teaching, requires a great variety of techniques to facilitate making valid evaluative decisions. According to Riener (1966), Walbesser (1963), Kurtz (1965) and many others, the main problem of current elementary science evaluation is that of developing tests of enquiry skills, concepts, problem-solving abilities and attitudes. Inextricably linked with the above is the concern of Cronbach (1960), Ahman (1960), Dale (1946) and others, for the damaging contamination of actual knowledge and understandings with reading ability.

This study was carried out to illustrate the viability of the pictorial test format with elementary science students of low reading ability.

Studies in a similar vein by Reese and Peckens (1968), Finklestein (1967), and Haney (1962) especially influences the style and procedure of this study; that is, the correlation of scores from a pictorial science test and identical reading form, with reading ability.

In order to test the hypothesis that there would be no interaction between reading ability and test effect (pictorial or reading), two science tests were devised and these were revised twice with the help of student interviews, professional educators' opinions and item analysis procedures.

The final test was administered to randomly assigned groups and to one repeated measures group. These groups were obtained from the total Grade 6 student population of the St. Paul area. Standardized reading test scores were obtained, in preparation for the testing of the hypothesis.

An analysis of variance on the final test results showed highly significant interaction between reading ability level and test effect (.002 level). The null hypothesis was therefore rejected, illustrating the importance and relevance of the pictorial testing technique for elementary science students of low reading ability.

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CHAPTER I

INTRODUCTION

Evaluation is an integral part of teaching, and as such must be adapted to suit the philosophy of the teaching approach being utilized. At present science educators generally regard the enquiry approach, which stresses pupil activities of observing, classifying, inferring, predicting, etc. (Kessen, 1967) in place of the memorizing of a body of knowledge, to be the most valid approach to science teaching. In line with this, the Curriculum Guide for Elementary School Science (Alberta, 1969) states that, "If the new approach in science is to succeed, a radical change in evaluation procedures is essential" (p. 9).

According to Tannenbaum, Stillman, and Piltz (1964) and to the National Society for the Study of Education (NSSE) (1960), a great variety of evaluative techniques are essential in order to evaluate completely all of the outcomes of the teaching-learning process. No single evaluative procedure can yield all the information one needs, because they all have their advantages and limitations. One of the largest evaluative problems with the new science programs is that of developing tests which will measure, in terms of behavioral objectives, enquiry skills, problem-solving abilities and attitudes, (Kurtz, 1965). One very good technique for testing all three is that of observation [recommended by American Association for the Advancement of Science (AAAS) and Science Curriculum Improvement Study (SCIS)] in which one uses a

check list or rating scale. However, this is a cumbersome tool and may often be inappropriate due to the need to give each pupil an even chance. Valid and reliable tests of understanding, in the form of problem situations, are needed to test the behavioral objectives of enquiry skills, concepts, problem-solving abilities and attitudes (Riener, 1966). This would be similar to the process instrument which AAAS is developing (Walbesser, 1963). Such tests would be invaluable in providing the wide range of information one needs in order to make valid evaluative decisions.

With this stress for new testing techniques has come an awareness and concern for the evaluation of any branch of knowledge as separate from reading abilities. Cronbach (1960) maintains that, "a valid measure of knowledge is not obtained if a person who knows a fact misses an item about it because of verbal difficulties." (p. 371). He cites several studies which have been done on navy mechanical and gunnery tests, and which have found that when verbal and pictorial forms were given, the verbal was undesirable because it measured reading ability rather than subject knowledge. Ahman (1960) believes that pictorial items lessen the reading load and do a better job of "...explaining the intent of the test item..." (p. 122-123), thus lessening the time needed. They lessen the artificiality and often ambiquous nature of paper and pencil test situations. He also lauds their use with grade 2 students. Ingram (1903) believes that one can manipulate words without actually understanding what they mean. He also says that "Verbal response is merely a label for the internal cognitive system" (p. 46).

Dale (1946) has said,

> "A picture can usually be understood even by illiterates. It uses a universal language. Alien peoples may have difficulty in finding precise and safe equivalents for words, but pictures offer few obstacles. Young children use picturebooks quite naturally. They 'read' the illustrations. For pictures are a unifying human medium, whatever the composition of the group,..." (p. 226).

According to Tannenbaum and Stillman (1954), pictorial test items can be utilized to measure a variety of objectives, can be used at all elementary grade levels and are especially important for pupils with "limited reading comprehension". Problems presented in pictorial format will instead be "...interesting, novel and realistic" (p. 43-44). In order to lessen the effect of reading handicaps in ability or achievement testing, pictorial items have been widely used, as in the following: The Peabody Picture Vocabulary Test, the Pictorial Test of Intelligence, the Army Examination Beta Tests, Culture Fair Intelligence Test, Progressive Matrices, and the Purdue Non-Language Test (Anastasi, 1957). They have also been used in the testing of the retarded and of illiterates (Finklestein, 1967).

A further use has been demonstrated with the Illustrated Science Test (Reese and Peckins, 1968) in Pakistan, Nepal and Guam with secondary school students for whom English is a second language. Aside from the advantages of the non-reading factor with these students, the Illustrated Science Test has also been used as a post-test teaching device. The teacher goes over each frame of all

items and shows the class why only one illustration is correct. In this manner, no individual is caused to 'lose face' by displaying a lack of understanding.

A study in the area of instructional media, by Gropper (1966), used a programmed instructional mode to study the learning of science concepts and principles on the basis of either visual (pictorial) or verbal (printed) presentation. He found that when a totally visual presentation preceded a printed one of the same concept, the learning was greater than when the printed preceded the visual presentation. He says further that students of below average I. Q., receiving instruction in programmed texts on science concepts, learned more easily by means of discrimination practice based on visual (pictorial) response items than by means of printed (verbal) stimulus-response items. He suggests that their previous experiences in responding to concrete attributes of physical objects and events make the pictorial presentation an easier task for them.

Other studies by Finklestein, Butler, Haney, Boener and Reese, utilizing pictorial formats, will be elaborated upon in Chapter II.

STATEMENT OF THE PROBLEM

It is believed that children must experience some degree of success in their school encounters because constant failure often produces anti-intellectualism and speeds up the drop-out process (Holt, 1964). In light of this, and from the previous discussion, it would seem that achievement testing procedures

should be developed which could tap the store of knowledge and the understandings of children of low reading ability, without penalizing them for their reading handicap. Some of the authors noted above have indicated that science is an area in which achievement, logical thinking, and problem-solving tests can be translated from the printed to the pictorial form. Such a pictorial test would be a much fairer measure of many students' scientific knowledge and ability than a written test and might reveal a level of performance perhaps previously unattainable.

The purpose of this study was to develop a pictorial science achievement test which required the students to formulate relevant hypotheses, to derive implications, and to use their conceptual knowledge. This test, by minimizing the reading factor, should enable the students with poor reading comprehension to achieve much higher levels of success. Comparisons were made with an identical but reading form of the tests, and scores from both tests were correlated with the students' scores on an English comprehension test.

GENERAL STATEMENT OF THE HYPOTHESIS

A pictorial format science test, as represented in this study by the Pictorial Science Test (PST), does not discriminate against those students who are poor readers. Hence it is a fairer measure of achievement than the conventional reading format science test, as represented in this study by the Reading Science Test (RST).

LIMITATIONS OF THE STUDY

1. The primary limitation lies in the development of the two tests by an investigator inexperienced in the area of pictorial testing. Despite access to, and cooperation from all available sources, the two tests may not be identical with respect to the scientific concepts they propose to measure. The Reading Science Test (RST) may be much more difficult for the students and difficulties exist in obtaining direct reading translations of the pictorial items.

2. The tests are strictly experimental. Although an item analysis was carried out and revisions made before the final testing, the tests were not really statistically proven to be valid or reliable on the basis of this research.

3. Control for the amount and type of science taught, or for the teaching method used could not be built into the study.

4. It is beyond the scope of this study to investigate actual perceptual or interpretive problems in the population. During the pilot study attempts were made to minimize these factors, but could not account for social-economic or cultural bias.

5. The pilot study group was urban, whereas the final test population belonged to rural and small town areas. This could lead to unforeseeable aberrations in the data and analysis.

6. The inclusion of an unequal number of test items involving the three formats (A, B, and C) in the final test forms may have had some unknown influence on the test results.

7. The use of three item formats in the pictorial test as opposed to only two in the reading science test, as well as the restriction of one format in both tests to biological science areas, could have had some effect on the results.

DEFINITIONS OF TERMS

For the purpose of this study, the following definitions and abbreviations will be used:

1. PST (Pictorial Science Test) - a science test developed for this study, consisting entirely of pictorial items, in three basic formats (Appendix C. p. 129).

2. RST (Reading Science Test) - a science test in a purely reading format which contains a direct translation of each pictorial item (Appendix C. p. 129).

3. Science achievement - the student's ability to use scientific knowledge and enquiry skills to solve pictorial and/or reading science test problems.

4. Reading ability - determined by the student's score on the comprehension section of the Gates-MacGinitie Reading Test. By this means, students were divided into three reading ability groups, low, medium and high, according to the variation of the total study population, and not to national norms.

5. PISK (Pictorial Inventory of Science Knowledge).

6. RISK (Reading Inventory of Science Knowledge).

7. IST (Illustrated Science Test).

8. KR20 (Kuder-Richardson-20 Reliability Co-efficient).

9. Format A - An item of three pictorial frames labelled A,B,C, only one of which illustrates a correct concept.

10. Format B - An Item consisting of an illustrated problem (something happening or about to happen) followed by three possible results of the action.

11. Format C - An item consisting of a group of three plants or animals illustrating a (group classification) concept. There are three plant or animal choices only one of which could belong to the same group, according to the concept involved. The students pick one of these, in order to expand the original concept group to four.

SUMMARY

In line with the need for new and better evaluative techniques for students with low reading ability, this study is being carried out to illustrate the potential usefulness of the pictorial test format in the area of elementary science. The study is limited by the methods used in the experimental nature of the tests, by the lack of control by the investigator over methods used in the teaching of students, by the perceptual problems of students, and by transfer from a pilot study involving an urban population to a final study involving a rural population. It is hoped to demonstrate, through a statistical study, that a pictorial format of science test (as represented by the PST) is a more genuine test of science knowledge and abilities than a reading format test (as represented by the RST) especially for students of low reading ability.

CHAPTER II

REVIEW OF RELATED RESEARCH

PRELIMINARY STATEMENT

Research in the area encompassed by this investigation is limited, but six studies have been conducted, one in 1952, one in 1962, two in 1966 and two in 1967. Generally, the objectives of these studies was to build pictorial instruments in order to formulate tests of science knowledge and abilites uninfluenced by reading ability. In several of the studies the results strongly indicated the desirability of utilizing this testing technique.

TYPES OF PICTORIAL TESTS IN SCIENCE

The 'Edmonton Picture Tests in Science' was developed in 1952 by Blacklock, with the assistance of the Elementary Science Committee. He intended it to be a completely pictorial evaluative device for use in grades four to seven. This now-obsolete test consisted of 54 items in the physical and biological sciences. However, in all 54 questions, the student was required to read the question , and in 15 out of the 54, to read the four possible choices. The pictures were thus mainly an accessory to the written word, success on the test still depending to a large extent upon reading ability.

Ten years later, in 1962, Haney became concerned with the lack of testing procedures designed to measure concepts. His Non-Verbal Concept Test (Animals) is concerned solely with concepts of a classificatory nature. Haney's problem was to develop a test which could be administered within a period of time appropriate for elementary school children, which would not require reading, and which would require the formulation and use of concepts related to the animal kingdom. Adapting the style of non-verbal items found in many psychological tests, Haney developed 40 items, each consisting of four animals grouped together and four choice pictures. The student had to discover the concept which enabled the first four objects to be grouped together, and then to use that concept to choose one of the four choice objects as a fifth member of the group in question. The concepts included in the test items were based on biological classification, locomotion, habitat, seasonal changes, life cycles, food-getting, protection, and man-animal relationships. After extensive testing of the reliability, validity and difficulty of the test (including correlation with the STEP Test), he concluded that the results indicated that the test was measuring childrens' conceptual thought processes. This study has many implications for one question format utilized in the present study.

Boener (1966) was also concerned with the measurement of science concepts, especially for children who could not yet read. With the use of line drawings, she developed a series of science test items for the kindergarten to grade two level. The teacher read the question and the possible answers while the child observed

the pictured event and answers. The child's response depended upon his understanding of the concept involved. Her reason for using this pictorial approach was the inability of children at this age to read the questions necessary for testing the concepts. Although her purpose was primarily that of curriculum development, she concluded that this test format was applicable for primary children (non-readers).

Butler (1966), also concerned with measuring concepts, designed a test to probe the development of concepts related to living things (structure, metabolism, growth, reproduction, responsiveness, adaptation) through grades one to six. The test consisted of 35 plates, each composed of six pictures. The teacher would read the question concerning the plate and the child answered "yes" or "no" to each picture. Butler found the scores ranged from 4.5 (grade 1) to 19 (grade 6) and believed that his results indicated the viability of the technique. However, the 50/50 probability of obtaining the correct answer in a yes-no situation limits the advisability of coming to far-reaching conclusions about his results.

In 1967 two tests were developed which relate directly to this present study. The first was by Finklestein who attempted to build a completely non-verbal science test. He believed that students who were reading below grade level were unable to indicate fully their science knowledge on conventional tests because of the difficulty involved in reading the test questions. He developed a multi-sensory (pictorial-aural) science survey test. The method involved the

projection of slides of real-life objects, coupled with a tape which asked the questions and supplied multiple-choice alternative answers (distractors). This test was known as the Pictorial Inventory of Science Knowledge (PISK). Believing that development of the reading-free test would be inadequate and invalid without an equated reading test, the Reading Inventory of Science Knowledge (RISK) consisting of the taped section of the PISK only, in written format, was used in conjunction with the PISK. The two tests were given to boys and girls in above average, average and low ability reading groups, with alteration of sequence of PISK and RISK to reduce the practice effect. It was found that all groups made higher scores on the pictorial test. The low reading group increased 83.6%, the average 15.6% and the above average 8.8% in achievement in the PISK over the RISK. The standardized reading test and PISK correlated 0.47 while the standardized reading test scores and RISK correlated 0.76. The low reading group scored almost as well as the above average group on the pictorial test. The PISK was therefore a fairer measure of the science knowledge of students with low reading ability, than the RISK.

In 1967, the Pakistani Government requested W. F. Reese and R. G. Peckens, of the Institute for Education and Research at the University of Dacca, Pakistan, to develop a science test to be used for selecting candidates for the military-operated cadet colleges of Pakistan. Information on this test has not as yet been published in the English language. Fortunately, however, the senior author of this test is this candidate's advisor and the following information

concerning the test has been obtained by means of a personal interview.

Prior to the development of the Reese-Peckens Illustrated Science Test (IST), highly unsatisfactory results had been obtained in Pakistan from the use of various English and American-made science achievement tests. All candidates for the cadet colleges were required to have obtained Pakistani matriculation (...roughly equivalent to grade ten in Alberta). Although each candidate was expected to be proficient in the English language, those in the English medium schools (all instruction in English) had a distinct advantage over students from the public schools (instruction in Bengali with English taught as a second language). Following an extensive study with various formats and over one hundred different illustrated questions based on the science syllabus for Pakistani schools, the authors published a three-frame version of the IST in 1968. This test consisted of fifty-six questions. Each question was represented by three pictorial frames, only one of which was correct. The questions were designed to test the scientific knowledge, aptitude, and reasoning ability of the examinees.

FURTHER RESEARCH WITH PICTORIAL TESTS IN SCIENCE

Since its publication in January, 1968, the IST has found wide acceptance and use in the selection of candidates for several scientifically and technically-oriented positions, by various branches of the Pakistani Government. Recently-acquired feedback has indicated a high degree of satisfaction with the candidates

selected by means of this test. Dr. Peckens, the co-author of the IST, has initiated a testing program of the IST in Guam, and the feedback from this has been promising (Reese, 1969).

Following a pilot study conducted in January and February of 1970, Reese received a grant from the University of Alberta General Research Fund for revision and further development of the IST. He is presently testing over 1200 grade four and five students with a revised forty-item version of the IST. Unfortunately, the results of this study were not available at the time of writing.

RELEVANCE OF RELATED RESEARCH TO THIS STUDY

The research and development of the IST was the initiating factor in the present study, which consists of an adaptation of this type of testing procedure to the elementary school. The three-frame form of the IST was first used as a model for the items developed by the author and in fact several items from the IST in identical or in slightly-revised form are included in the PST.

Haney's work in the development of the Non-Verbal Concept Test (Animals) indicated the type of format which could be utilized to test concepts relating to plants and animals.

Finklestein's work, which employed two tests, (a pictorial-aural one and a reading translation of it), indicated the necessity for pictorial testing techniques for students of low reading ability. The present study was modeled after his procedure.

SUMMARY

The studies outlined in this section have illustrated the importance and worth of pictorial testing techniques. Several of them [notably those of Reese and Peckens (1967), Haney (1962), and Finklestein (1967)], have had a profound influence on the style of and procedures used in the present study. The three-frame form of the IST formed the model for the majority of the items. In fact, the PST incorporated several items from the IST to test pictorially many of the biological concepts included in Bulletin 2B of the Alberta Department of Education. Finlestein's procedure of developing a study around the comparison of pictorial-aural with identical reading science tests formed the basic procedure for this study.

CHAPTER III

RESEARCH DESIGN

PRELIMINARY STATEMENT

A three-part pictorial science test of knowledge and enquiry skills was developed, using the format of the Illustrated Science Test (Reese and Peckens, 1968), the Non-Verbal Concept Test (Haney, 1968), and various psychological tests. The test was based upon the topics indicated in the Curriculum Guide for Elementary School Science which was used in the Alberta schools prior to the inception of the new interim guide in the Fall of 1968. It was decided to base the tests on the old curriculum because the majority of students had been exposed to it from grades one to six and because many teachers, due to unfamiliarity with the new science approach, were still adhering to the old curriculum (even in those urban areas observed during student-teaching supervision).

A reading science test, identical, item-for-item, to the pictorial test, but in a multiple-choice format, was also constructed. Revisions were made following interviews with children and science educators regarding the pictorial items. A pilot study of the pictorial and reading forms was then carried out and this was followed by an item analysis and by the preparation of the final form to be used in the study.

Several evaluations as to the equivalence with respect to

science content of the two tests were obtained from members of the Department of Elementary Education, University of Alberta, and from teachers of elementary science in the target population. (Appendix D)

Student scores on the Gates-MacGinitie Reading Test were obtained in order to compare these with the pictorial and science reading test scores.

CONSTRUCTION OF PICTORIAL TEST ITEMS

All of the items in the test, with the exception of the twelve items from the IST, were developed and drawn by the author. Any similarity to pictures or items in other books or tests is purely coincidental. Considerable attention was given to the five rules set up by Haney for the development of the items in part three of the PST (Haney, 1962). These rules were as follows:

"1. The pictures used in the items must be of animals familiar to the pupils or about which they can be expected to have some knowledge...

2. The four objects pictured in the upper concept group must be diverse exemplars of the concept...

3. The correct alternative at the bottom of the page should be as different as possible from the objects pictured in the upper group...

4. The distracters, or alternate responses, should be as similar as possible to the correct alternative yet not be a member of the conceptual group...

5. The distracters should be as different from one another as possible..." (Haney, 1962 P. 71)

After the initial construction of the items, ten students of varying science and reading abilities, were interviewed regarding the items in order to identify and clear up any problems such as inability to recognize a drawing, inappropriate alternate responses, unfamiliarity with plants, animals or other objects illustrated, according to the rules set up by Haney.

Several item revisions were made on the basis of these interviews. A summary of the interview responses appears in Appendix A, p. 44. The resulting first form of the test appears in Appendix B, p. 79.

Consultations with Dr.W. Reese and with several practicing Division II teachers in the ESSB indicated that the reading items were as direct a translation of the pictorial items as could be accomplished. The reading level was kept as close to the grade 5-6 level as possible. This was further confirmed by the author's teaching experiences with grade six students of both high and low reading ability.

PICTORIAL ITEM FORMAT

Three types of item format were employed. The first of these was based upon the format found in the IST (Reese and Peckens, 1968) in which each item consists of three pictorial frames labelled A,B,C, only one of which illustrates a correct concept. The final form of

the test contained nineteen questions of this type. For the purpose of this paper this format is called Format A. (Appendices B and C).

The second item format consists of an illustrated problem, a picture of something happening or about to happen, which is followed by three illustrations of possible results of the action (A,B,C). This format is a translation of the type of written item often found in science tests, critical thinking tests and/or psychological tests. The final form of the test contained 13 such questions. For the purposes of this paper, this format is called Format B. (Appendices B and C).

The third item format was derived from that used in the Non-Verbal Concept Test (Haney, 1962). Haney places four pictures of animals which formed members of a group at the top of the page, and put four separate choice objects only one of which could belong to the group at the top, at the bottom of the page. Using Haney's idea, the author of this study developed fifteen questions, each illustrated by a group of three plants or animals and each accompanied by three possible choices. For the purposes of this paper this format is called Format C. (Appendices B and C).

TEST ITEM CONTENT

It was decided to base the test on the old science curriculum guide for Alberta Schools (Bulletin 2B, Curriculum Guide for Elementary Science). There were many reasons for making this decision even though the new science program for Alberta schools has been introduced in the fall of 1968. The principal reason however, was based upon

the fact that the majority of teachers were unsure of the new enquiry approach and lacked the materials (both scientific and textual) to carry it out effectively. Also, almost the entire test population had been taught on the basis of the program and methods set out in the previous curriculum guide and according to the content of the science texts recommended in Bulletin 2B. These texts were as follows:

1. Science Today and Tomorrow (1-6) (Craig and Daniel, 1961).
2. Discovering Our World(1-6) (Bauchamp, Williams and Blough, 1952).
3. Exploring Science (Thurber, 1957).

The test content was therefore based upon those segments of the biological, earth and physical sciences to which the students had been exposed.

Several items of the IST were applicable within this context and, with the permission of W.F. Reese, were included in the test.

PILOT STUDY

The first form of the test was administered to 225 students from three schools in the Edmonton Separate School Board in May, 1969. The students were all in grade six and were randomly-assigned (according to a list of random ones' and twos' generated by a computer) to the group taking the Pictorial Science Test (PST), or to the group taking the Reading Science Test (RST). In total, 120 students were assigned to the PST and 105 students to the RST.

The results of the testing program were subjected to an item analysis. From this analysis one obtains six main statistical aids to deletion, revision, and ordering of test questions. The information resulting from the test analysis includes: (1) the number choosing the correct answer, and the number selecting each of the distractors; (2) the number of students from the highest and lowest groups who selected the correct response; (3) the biserial correlation; which indicates how well the results for an individual items correlate with the total test score; (4) the z-score which indicates the item difficulty (0.0 being average and -1 or +1 indicating extreme difficulty or easiness); (6) test reliability according to the Kuder-Richardson 20 formula.

Results of the analysis of the PST test scores yielded an arithmetic mean of 27.40 (total of 52 questions) and a KR-20 reliability of 0.6545 for the test.

The RST score analysis yielded an arithmetic mean of 24.50 and a KR-20 reliability of 0.5684.

According to the item analysis statistics (a summary of which appears in Appendix B, p. 79) items 3,18,25,42 and 48 were deleted from the tests. Items numbered 4,6,7,9,11,12,14,16,17,19,23, 29,33,34,35,39,41,43,44,46, and 51 were revised in the pictorial form of the test. Items numbered 1,6,8,9,11,12,13,14,16,17,19,20 21,23,27,29,33,34,35,39,41,43,44,46,51, and 52 were revised in the Reading Science Test form. The order of the items was also changed so that the easier items were at the beginning and the most difficult

ones were at the end, according to item difficulty index (obtained from the item analysis). The order of the items on both the PST and the RST was made to match.

Although the test results were not subjected to an ANOVA (Analysis of Variance), it is interesting to note that one class which was designated as a low-average group obtained a mean of 27 on the PST and a mean of 21 on the RST. In all other classes, the arithmetic means were generally one to four points higher on the PST. These results were encouraging from the point of view of continuing the study. (Appendix B, p. 79).

FINAL TEST FORMAT

The final forms of the test were then prepared. The pictorial form consisted of a total of forty-seven items, nineteen of which were in Format A, thirteen in Format B and fifteen in Format C. The reading form consisted of a verbal translation of all forty-seven items in the same order as those of the pictorial test. However, when translated into words, the first two item formats became identical, consisting of a stated problem with three possible choices, as can be easily seen when one compares the two final test forms in Appendix C. The reading science test thus consisted of two sections, one of thirty-two questions combining the first two sections in the earth, physical sciences, biological sciences, and the other of fifteen in biological sciences only. The final versions of the tests, although improved upon by the pilot study still had many limitations, as described in Chapter I.

POPULATION FOR ADMINISTRATION OF FINAL FORM

The total test population consisted of all the grade six students in the County of St. Paul (220 students), St. Paul Public School District #228 (127 students) and Glen Avon School in St. Paul (33 students). Since a random selection of 200-250 students (the smallest number needed for a post-test item analysis) out of a total of approximately 350 would not be that meaningful, it was decided to utilize all of the students in the geographic area of St. Paul.

Both urban and rural students were included in the population. Three main language groups (English, French and Cree) were also represented in the population. Both these variables were taken into account by random assignment of all students to either the PST or the RST, so that no particular group would be at a disadvantage.

EXECUTION OF THE STUDY

In late May and early June of 1969, the final forms of the PST and RST were administered to the population of the St. Paul area noted in the previous section.

Since the time for this study was very limited (schools limited the amount of time they will allow you to disturb them in the spring), the majority of the students were assigned randomly (according to a table of random numbers generated by a computer) into pictorial and reading test groups. However, repeated measures were obtained, ten days apart, on one group of 40 students, which enabled the author to draw some conclusions with respect to the

equivalence of the pictorial and reading forms of the science tests, in the area of content being measured. The pictorial and reading test groups were alternated to reduce the practice effect.

Following the data collection, an item analysis was performed on the results to ascertain whether or not the revisions made after the pilot study had improved the test. The item analysis was also helpful in comparing the test responses of the repeated measures group, in developing any meaningful hypotheses as to the equivalence of content being measured by the two tests RST and PST).

SUMMARY

In order to test the stated hypothesis (p. 5), two science tests of pictorial and reading format were developed by interview and testing/item-analysis techniques. The tests were then given to randomly assigned groups and to one repeated measures group. Standardized reading test scores were also obtained in order to test the hypothesis. This was then accomplished by means of an analysis of variance between the results obtained on the two forms.

CHAPTER IV

STATISTICAL ANALYSIS

ITEM ANALYSIS OF FINAL FORMS OF SCIENCE TESTS

The final pictorial form of the test yielded a mean score for the test population of 27.10 and a KR-20 test reliability of 0.6924. The Reading Science Test yielded a mean of 25.12 and a KR-20 reliability of 0.6557.

According to this analysis, in twenty-eight of the items, the students performed better on the pictorial format test. In general, about one half of the revisions produced better items. Still better results might have been obtained with the revised test if the final testing had not been done with a rural population of so different a make-up from that of the pilot study population.

The reliability of the test was also probably impaired by putting the test through only one major revision instead of several (due to the previously explained time limits of the study).

STATISTICAL DESIGN

Since the two tests are obviously different, as a study of the formats indicates, and since it is reasonable to surmise that the results of applying these two tests will in turn be different, it is necessary to determine to what these differences can be attributed.

As explained earlier in this Chapter, the tests were specifically designed to eliminate any variation in test results attributable to differences in scientific subject content between the two test formats. Differences in results can occur because of differences of knowledge between individuals in the test group. To avoid this, all individuals in the test group were randomly assigned to the Pictorial or Reading Science Test. This randomization was accomplished by matching a pseudo-random sequence (generated on the 360/67 computer APL system) of the digits one (1) and two (2) against a list of the subjects, sorted alphabetically within their classes. Those individuals whose names were matched with a one (1) from the pseudo-randome sequence were assigned to the Pictorial Science Test. Similarly, those being matched to a two (2) were assigned to the Reading Science Test. This random assignment of tests should neutralize the effects of science knowledge on the results of the two tests (PST and RST).

In the actual application of the tests, some students were absent and it was assumed that this was also random, and would have no direct effect on the test results.

The main remaining causes of variation in results between the tests were due to differences in the ability of students to interpret the Pictorial and Reading items of the two tests. These were in fact the variables which the author was intending to determine.

All test subjects also took the Gates-MacGintie Reading Test. The students were classified into low, medium, or high reading ability groups depending upon whether their Gates-MacGinitie score

fell into the bottom, middle or top third of the group scores, respectively.

This set of data conforms to a 3X2, Two-Way Analysis of Variance (ANOVA) factorial statistical model. The A factor is the reading ability groups and the B factor is the science tests (PST and RST).

A significant A effect would mean that there was an effect attributable to the reading abilities of the students. This was expected since the RST was highly biased toward measuring reading ability. If a significant A effect did not exist, then part of the original hypothesis would be invalid. That is, it would mean that there was no apparent reading factor in the RST.

The B effect is the result of differences in levels of scores due to variation between the PST and the RST. By construction, the variations are due to differences between interpretation of the pictorial and reading formats. Any differences in the levels of achievement between the reading groups of the PST and of the RST are of minor importance. What is important is the difference of the correlations between reading ability and test scores, for each of the science tests (PST and the RST).

For instance, if there had been no significant B effect and there was no significant difference between the correlations of the test scores and reading ability, for each test, this would have been interpreted to mean that both tests were measuring the same things. That is, that there was no difference in the amount of reading ability reflected in the scores of both the PST and the RST. This situation would have resembled that shown in illustration A p. 29.

Conversely, if the B effect had been found to be significant, but the correlations were not significantly different, as in Illustration B, p. 29, it would have indicated a uniform bias to all reading groups. This would have indicated that there was no significant value of the pictorial format over the reading format as far as discrimination between reading ability groups would be concerned.

If there had been a significant B effect and also a significant difference between the correlations of test scores to reading ability (See Illustration C, p. 29.), then the important point would be the significance of the difference of correlations. It would indicate that one of the tests discriminated to a relatively lesser extent against the poor readers.

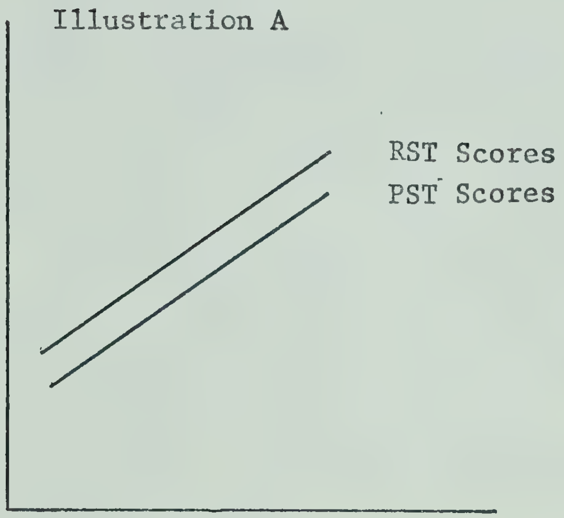
If there had been no significant B effect, but there was a significant difference between the correlations of science test scores to reading ability, for both science tests, this would have been interpreted to mean that one form of the test favored the student of high reading ability. If that test had been the RST, then the tendency would have been to support the general hypothesis. See Illustration D, p. 29.

Hence, a significant B effect would have been an unimportant result in this study. It was of central importance, however, to establish the significance of difference of the correlations between reading ability level and the two science tests, in order to support the hypothesis.

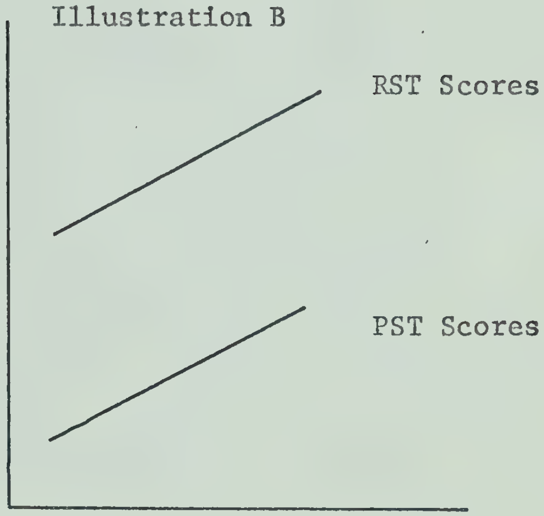
A difference in correlations between the scores for each of the tests would have indicated that the effect of the PST on the

ILLUSTRATION I

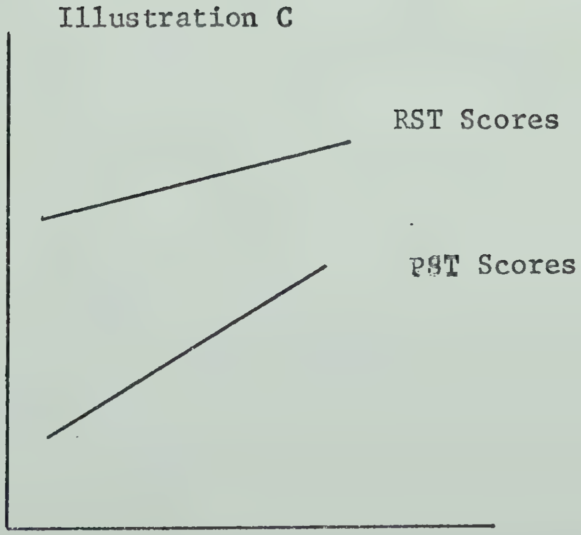
INTERACTION, COMBINED WITH A AND B EFFECTS



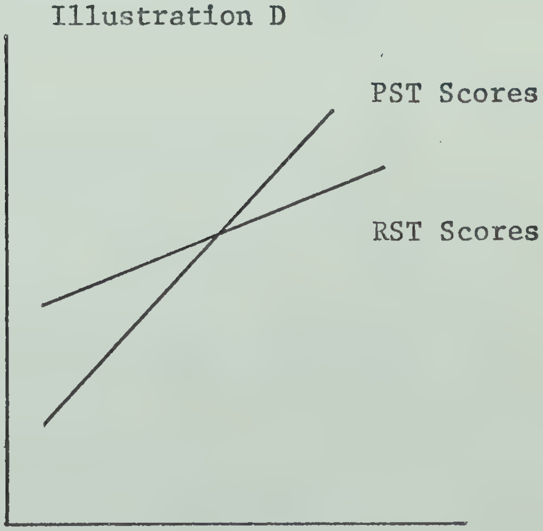
No Significant B Effect and
no Significant Interaction



Significant B Effect
no Significant Interaction



Significant B Effect
Significant Interaction



No Significant B Effect
Significant Interaction

science scores was different from the effect of the RST on the science scores. In terms of the Analysis of Variance (ANOVA) model, this would have meant a significant interaction. Therefore, testing for a significance of interaction was a satisfactory means of testing for significance of the difference of correlations between reading ability and science test scores, in this study.

As discussed above, if a significant effect had been observed, and if the test which was more favorable to students of low reading ability was the PST, this would be interpreted to support the hypothesis, with one proviso. Interaction could have been caused by a 'ceiling' or 'bottoming' effect.

A 'ceiling' effect would be caused by an effective maximum score being achieved by a significant number of students. If the scores of the students affected were at the high end of the graph, it would produce a levelling-off of the graph. Similarly, a 'bottoming' effect would be caused by an effective minimum score being achieved by a significant number of students, thus possibly causing a levelling-off of the low end of the graph.

A 'ceiling' or 'bottoming' effect that would cause an interaction could be detected by deviations from the normal distribution of test scores for the test in which the effect occured. A chi-square (X^2) test for normal distribution was used to detect any significant deviations from normality.

STATISTICAL STATEMENT OF THE HYPOTHESES

There were three hypotheses to be tested.

1. There is no significant interaction between the A effect (reading ability) and the B effect (science test applied).

2. The distribution of test scores from the PST is normal.

3. The distribution of test scores from the RST is normal.

Hypothesis one (1) will be accepted if the probability of obtaining an F equal to or greater than the F obtained is one percent (1%) or better. Hypotheses two (2) and three (3) will be accepted if the probability of obtaining a chi-square (X^2) as large or larger than the absolute X^2, given the same number of degrees of freedom, is five percent (5%) or greater.

If hypothesis one (1) is rejected and hypotheses two (2) and three (3) are accepted, and if the PST is the test relatively more favorable to those of low reading ability, then these results will be interpreted to support the general hypothesis of Chapter One. That is, that the pictorial format does not discriminate against students of low reading ability, and is a more fair test of science achievement than the written format.

TESTING OF HYPOTHESES

Hypothesis one (1) states that there is no interation between reading ability level and test effect (pictorial or reading) and further, that the hypothesis would be rejected at the .01 level of significance. However, the ANOVA showed highly significant interaction, meaning that the probability of obtaining an F as large as that observed, under the null hypothesis, is approximately 0.002.

Therefore, the null hypothesis was rejected at the previously stated 0.01 level. See Illustration 2, p.33, and Illustration 3, p. 34.

Hypothesis two (2) states that the distribution of test scores from the PST is normal. It was further stated that this hypothesis would be accepted if the probability of obtaining a chi-square (X^2) as large or larger than the observed X^2, given the same number of degrees of freedom, is 5% or greater. The observed X^2 was 20.402 with 19 degrees of freedom. The probability of obtaining a X^2 as great or greater than this value, with the same number of degrees of freedom, is 37.076%. Therefore the hypothesis is accepted. (See Illustration 4, p. 35.)

Hypothesis three (3) states that the distribution of test scores from the RST is normal. It was further stated that this hypothesis would be accepted if the probability of obtaining a chi-square (X^2) as large or larger than the observed X^2, given the same number of degrees of freedom, is 5% or greater. The observed X^2 was 8.595 with 17 degrees of freedom. The probability of obtaining a X^2 as great or greater than this value, with the same number of degrees of freedom, is 95.210%. Therefore, the hypothesis is accepted. (See Illustration 4, p.35).

ILLUSTRATION 2

ANALYSIS OF VARIANCE

```
ANALYSIS OF VARIANCE TABLE

SOURCE  SUM OF SQUARES    D.F.    MEAN SQUARES     F RATIO      PROBABILITY
SA      0.920625E 03        2.    0.460313E 03   18.131699      0.000006(Gates-MacGinitie)
SB      0.209438E 03        1.    0.209438E 03    8.249741      0.004454(PST and RST)
SAB     0.323500E 03        2.    0.161750E 03    6.371330      0.002024(Interaction)
SE      0.586444E 04      231.    0.253872E 02



TEST FOR ADDITIVITY

SOURCE  SUM OF SQUARES    D.F.    MEAN SQUARES     F RATIO      PROBABILITY
SAB     0.323500E 03        2.    0.161750E 03    6.371330      0.002024(Interaction)
SE      0.586444E 04      231.    0.253872E 02



CELL MEANS MATRIX
        COLUMN                    1(PST)                        2(RST)

        ROW 1                     0.263953E 02                  0.215428E 02
        ROW 2                     0.262857E 02                  0.245555E 02
        ROW 3                     0.282558E 02                  0.291667E 02
```

ILLUSTRATION 3

PST and RST mean scores for low, average, and high average reading ability groups. (according to the Gates-MacGinitie Reading Test)

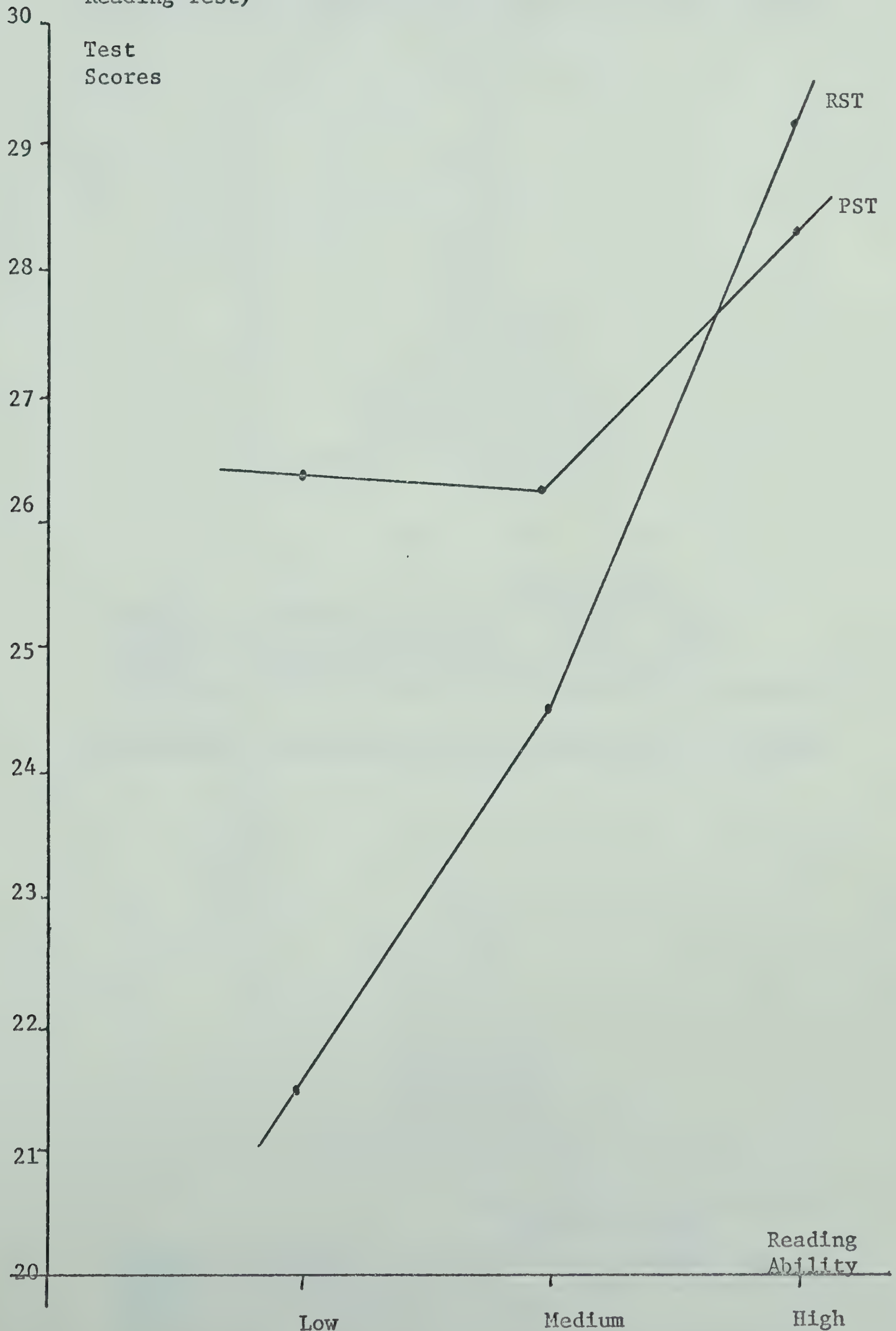


ILLUSTRATION 4

```
HISTOGRAM OF RAW SCORES FOR THE PICTORIAL SCIENCE TEST(PST)

16
15
14
13                *
12                * *
11                * *
10                * * *
 9              * *** *
 8              * *** *
 7              ******* *
 6          *   ******* *
 5          * * ******* *   *
 4         ** * *********  **
 3         ** * ********* ***  *
 2 *       ******************  *
 1 *  **************************
   *----*----*----*----*----*---


   1    5    10   15   20   25  30

                    INTERVAL NUMBER
RAW DATA - SKEWNESS = -0.220  KURTOSIS =  0.132
GOODNESS OF FIT TO NORMAL CURVE - CHISQ = 20.402
DEGREE OF FREEDOM = 19  PROBABILITY = 0.37076
(CALCULATED BY POOLING EXPECTED FREQUENCIES LESS THAN 2)
```

```
HISTOGRAM OF RAW SCORES FOR THE READING SCIENCE TEST(RST)

14
13
12                  *
11                  *
10                  *
 9                  * *
 8            * *  ** *
 7            **** ****
 6            *********
 5            ********* ***
 4     *  * ********* ***
 3     *  ****************
 2     ******************* *
 1    **********************  **
      *---*----*----*----*----*-

      1   5    10   15   20   25    30
                     INTERVAL NUMBER
RAW DATA - SKEWNESS = 0.140  KURTOSIS = -0.252
GOODNESS OF FIT TO NORMAL CURVE - CHISQ = 8.595 DEGREES OF
FREEDOM = 17  PROBABILITY = 0.95210
(CALCULATED BY POOLING EXPECTED FREQUENCIES LESS THAN 2)
```

SUMMARY

Tests of the statistical hypotheses indicate that the data fits the Analysis of Variance model (i.e. normal sample distributions) and that the correlation of science test scores to reading ability is significantly higher for the Reading Science Test (RST) than for the Pictorial Science Test (PST).

CHAPTER V

CONCLUSIONS AND IMPLICATIONS FOR FURTHER RESEARCH

CONCLUSIONS

1. The PST appears to be a reading-free measure of science knowledge and ability. The PST scores are significantly less highly related to reading ability than the RST scores. Students with poor reading ability were penalized by the RST. When they took the PST many scored nearly as well as the students of high reading ability.

2. Ceiling or bottoming effects do not appear to influence the results, as the scores on the PST and the RST are normally distributed.

IMPLICATIONS FOR FURTHER RESEARCH

The findings of this study carry strong implications for a re-examination of the testing techniques used with below-average readers in science. The reliance of the majority of the teachers on science tests with a reading format cannot help but create feelings of frustration, failure and inadequacy in those students who do have knowledge and understandings of science but are unable to interpret questions presented in a written format. These students are being tested in an inappropriate manner and the actual extent of their

knowledge remains unknown to the teacher. Therefore, the following implications appear to be relevant:

1. Pictorial testing techniques, in science, should be developed for use with students who have a reading handicap and in addition should be considered for those who are retarded, for those who have a dual-language cross-cultural problem, and for kindergarten or grades 1-2 students who are unable, as yet, to read proficiently.

2. The pictorial test developed for this study should be revised in order to achieve correlation with the new Alberta science curriculum and with aspects of enquiry found in other science programs like the AAAS, or the SCIS. This might necessitate the development of another type of test format. Suggestions in this area could include motion pictures (with or without sound), or any other combination of audio-visual equipment, or actual experimental manipulation (or observation) by the student.

3. Pictorial tests like that in this study should be developed and used in individual, oral testing situations. From such sessions the teacher could gain a much better grasp of the student's understandings, weaknesses and real problem areas.

4. Further research involving the PST and RST should be instituted involving larger numbers of Indian students in order to discover any important implications of the use of pictorial items with groups having English as a second language.

SUMMARY

This study has illustrated the importance and relevance of the pictorial testing technique for elementary school students of low reading ability.

Highly significant interaction was found between reading ability level and test effect, in other words, students of low reading ability were able to do significantly better on the PST than on the RST. A ceiling effect, which could have affected the results, was not present. The desirability for further research with the PST in the areas of cross-cultural or dual-language teaching situations, early childhood classes, retarded children and individual testing and analysis situations is indicated.

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APPENDIX A

(Note: Correct answers are indicated by a circle around the item letter)

FORM I - INTERVIEWS

PICTORIAL SCIENCE TEST

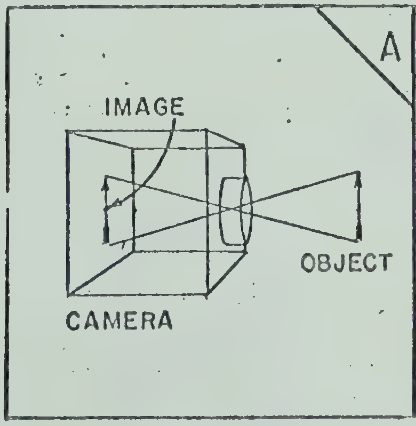
SECTION ONE

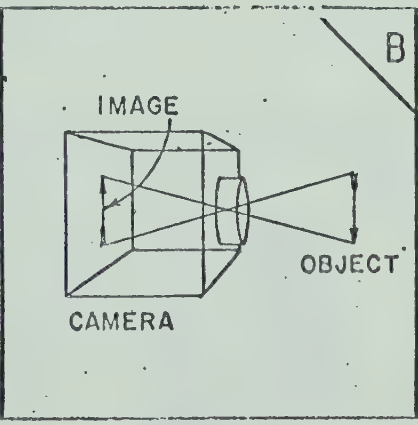
Do not write in any way on the pages of this booklet. Place your answers on the separate answer sheet.

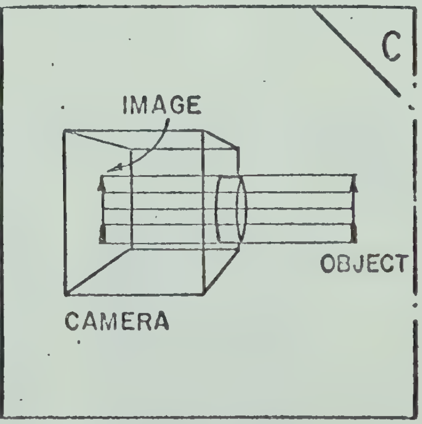
In each of the following 25 questions you will be given a problem to solve. It will involve a scientific concept. Only one of the possibilities, A, B, or C is the correct solution. On the answer sheet you will see A 1 B 2 C 3 D 4 E 5 Only spaces A, B, or C should ever be marked. Do not put any marks in spaces D or E. If you wish to change an answer, you must erase it completely. Then clearly mark the answer you prefer.

Here are two sample questions;

Example 135

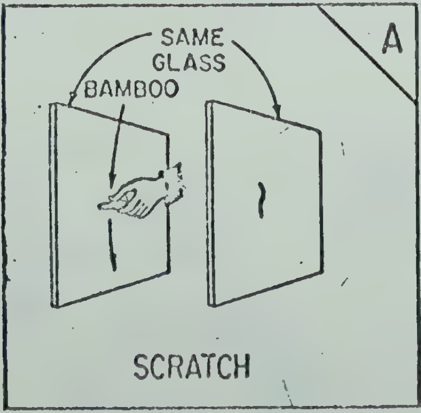


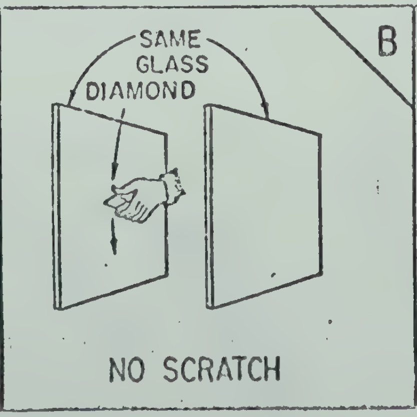


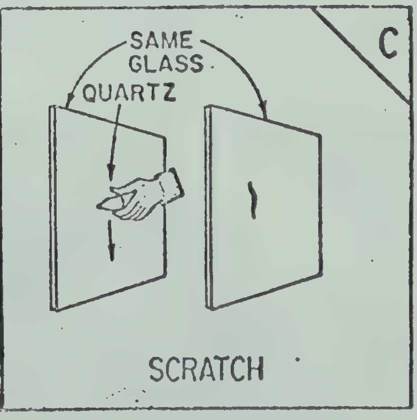


Beside # 135, you should have marked B like this B 2

Example 136







Which answer did you choose?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

DO NOT MARK THIS PAGE

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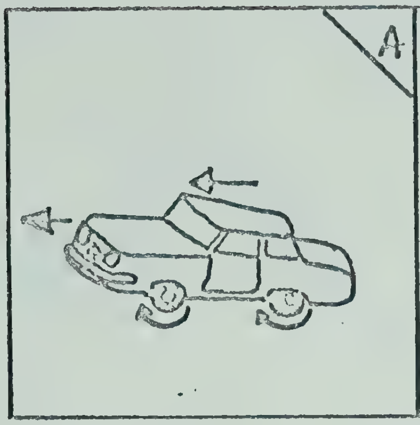

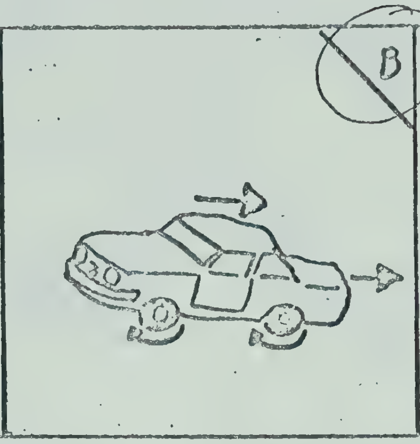

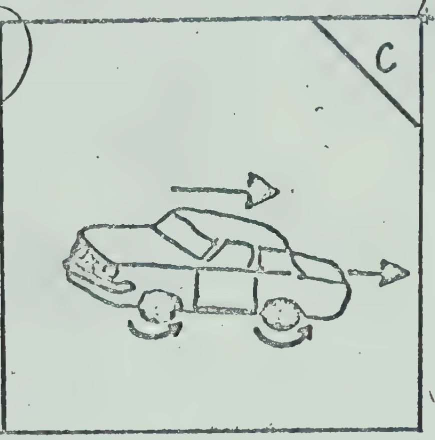

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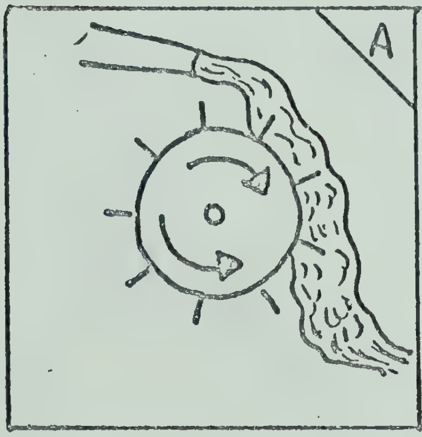

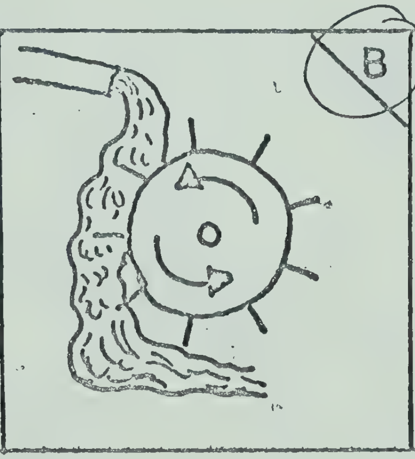

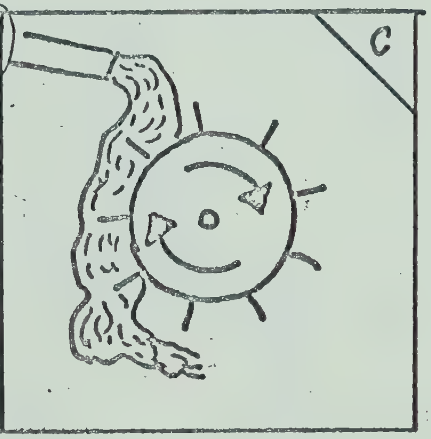

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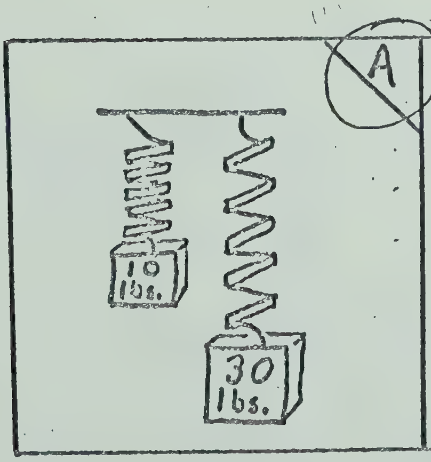
A
10 lbs.
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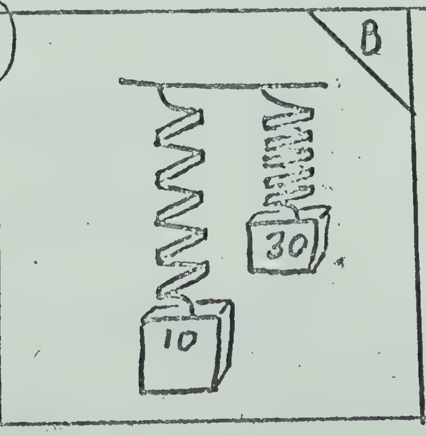

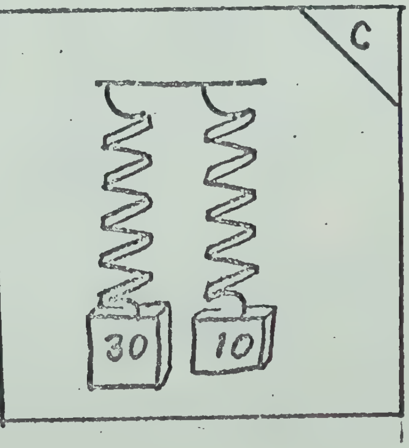

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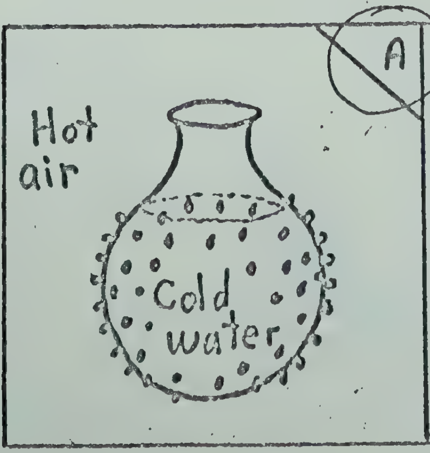

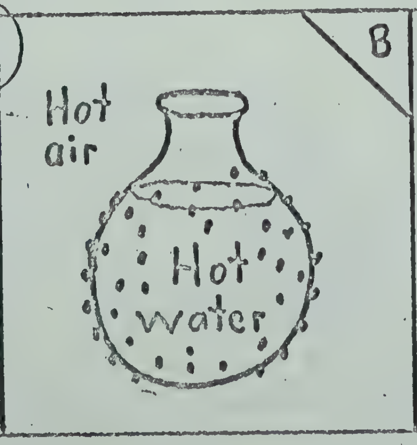

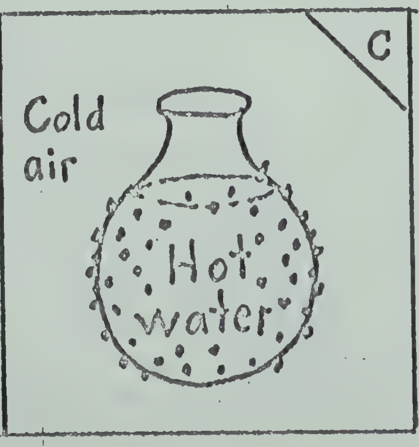

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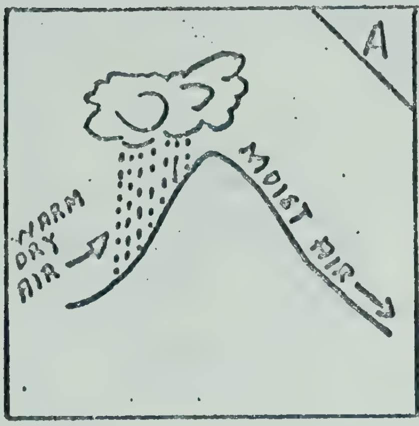

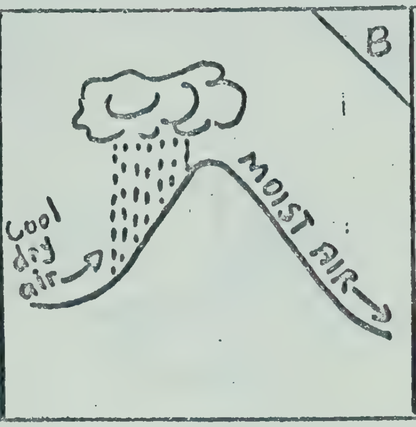

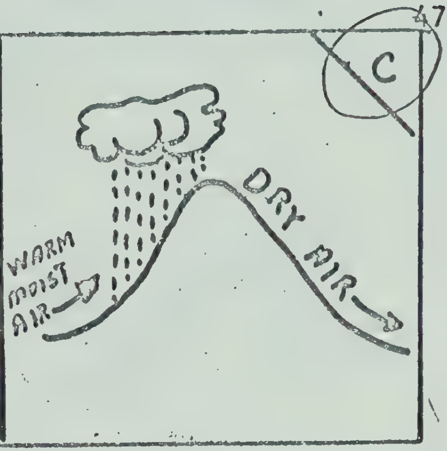

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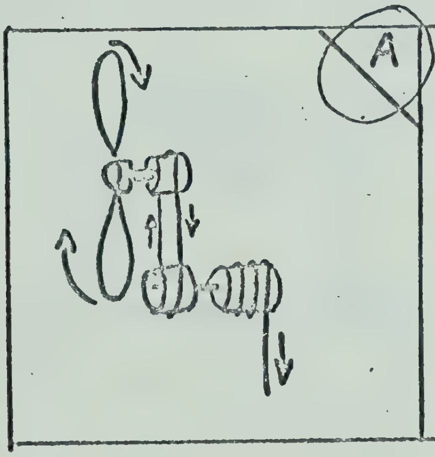

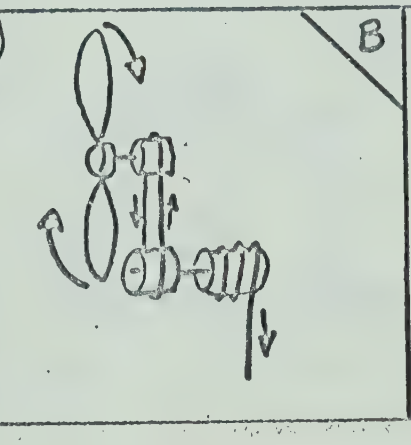

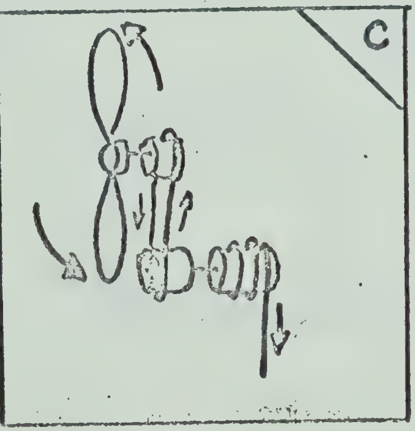

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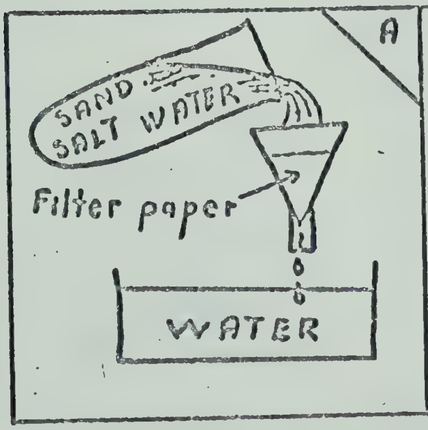

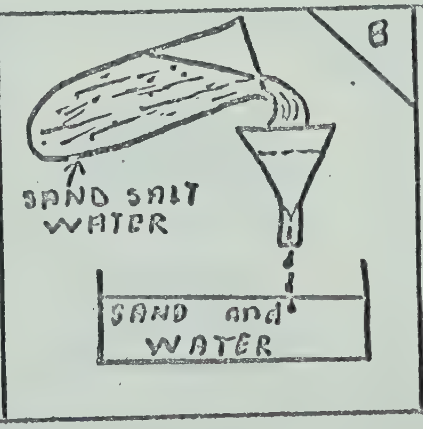

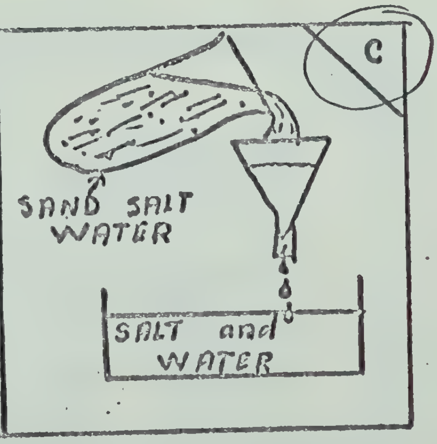

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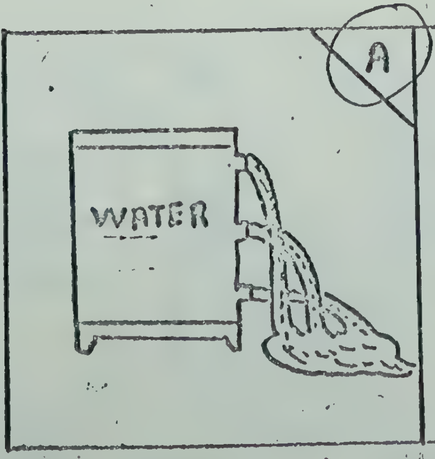

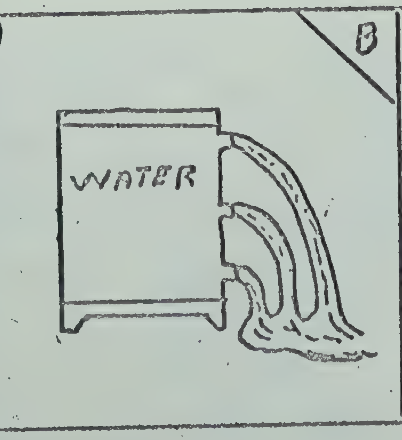

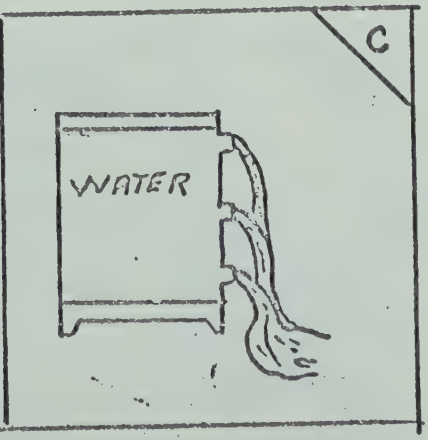

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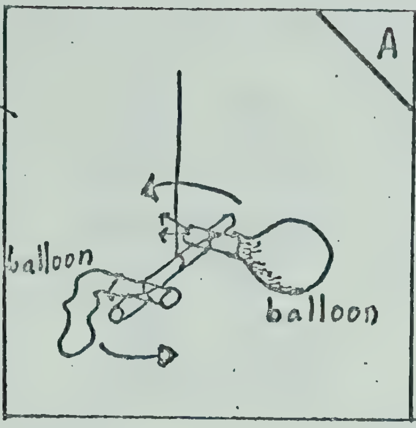

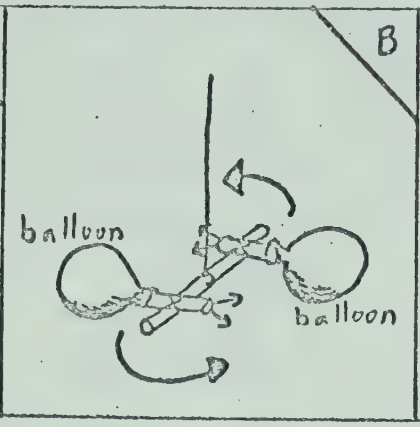

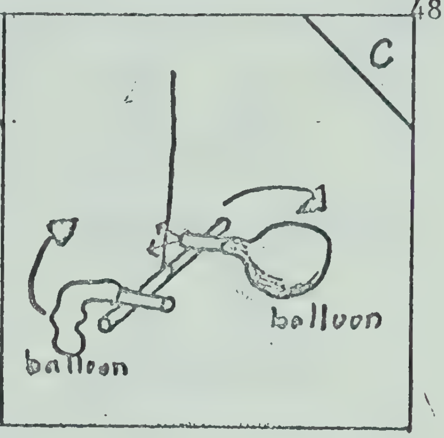

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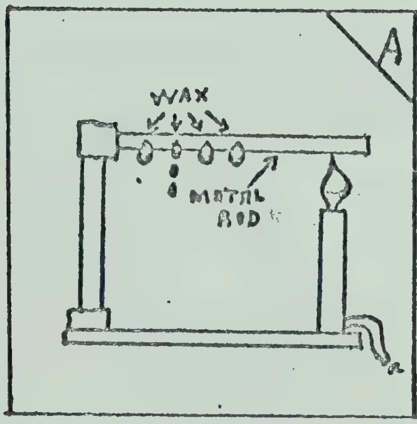

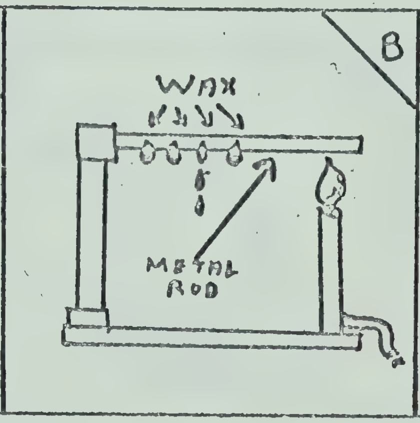

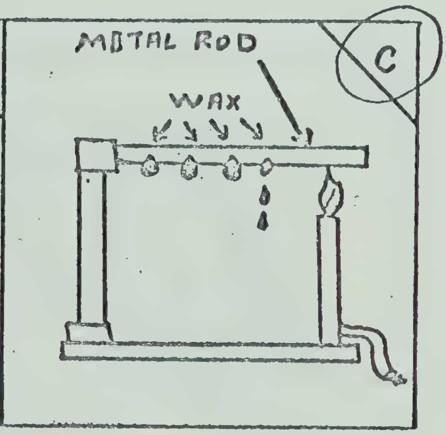

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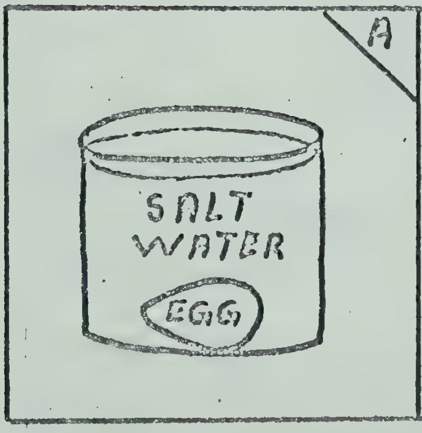

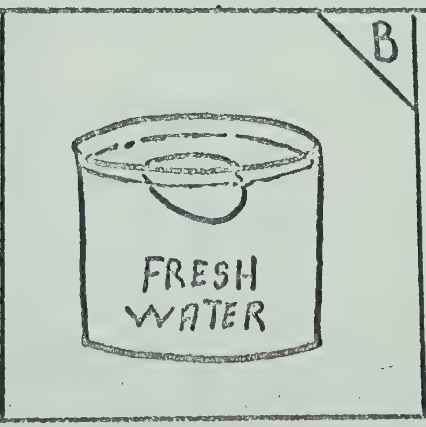

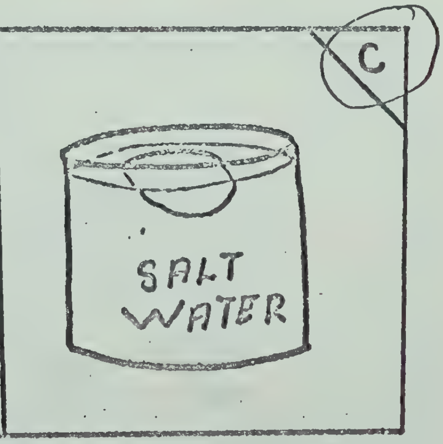

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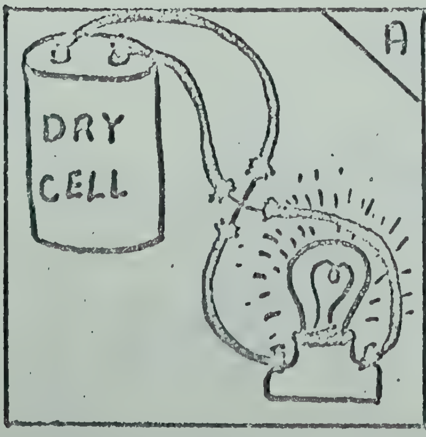

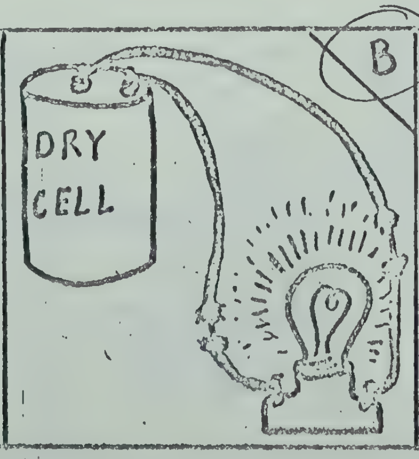

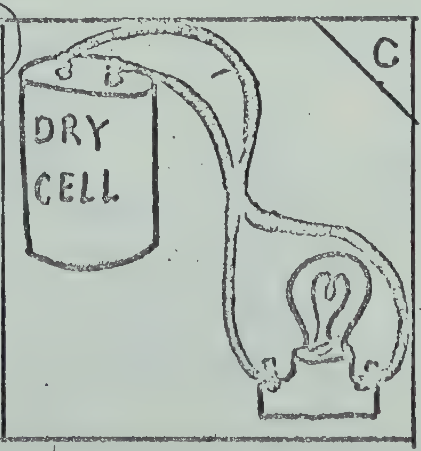

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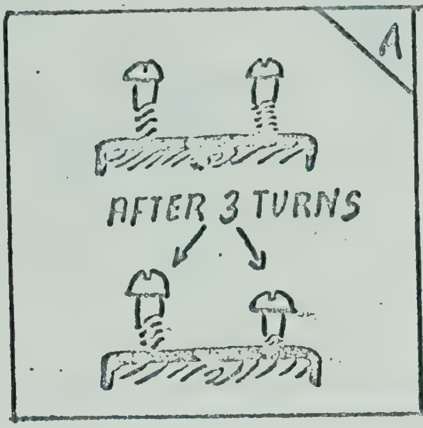

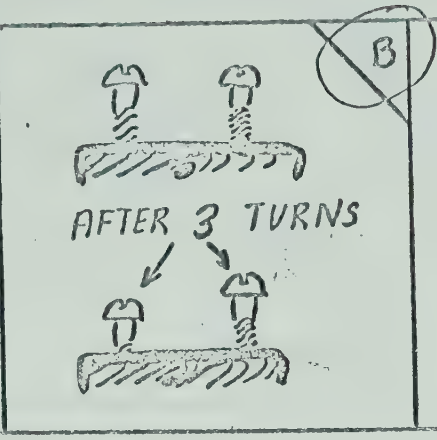

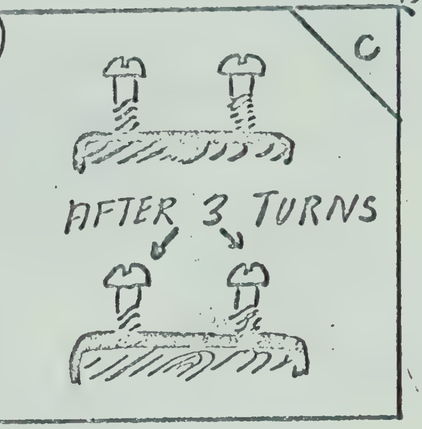

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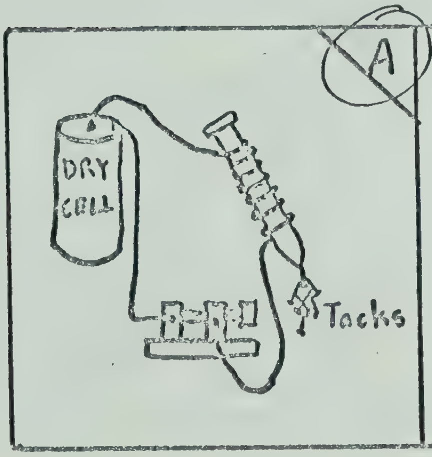

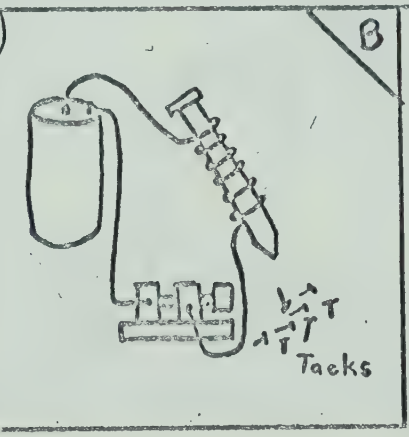

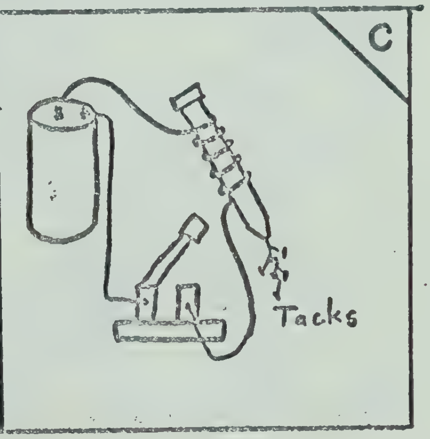

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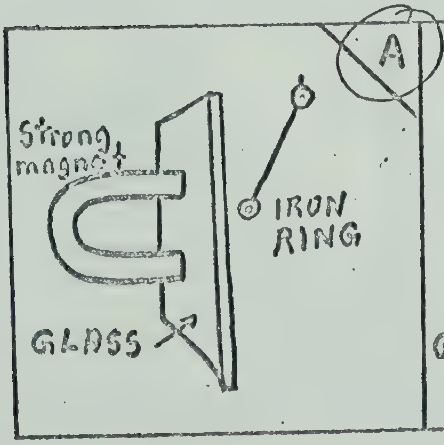

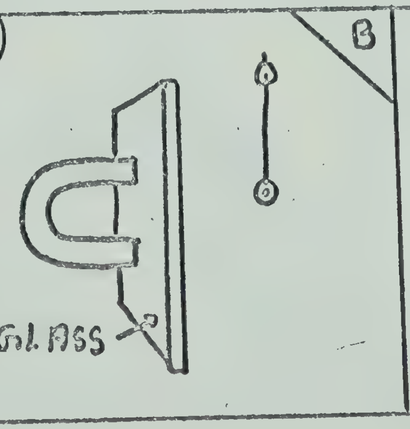

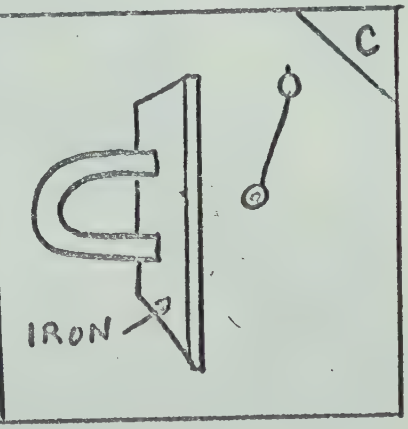

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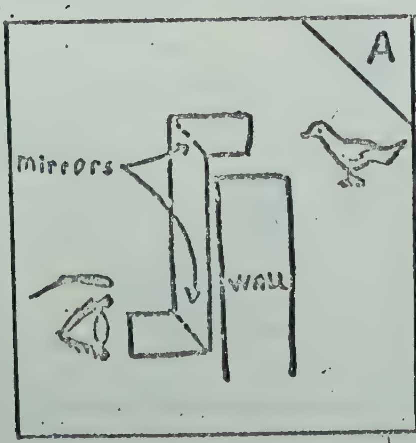

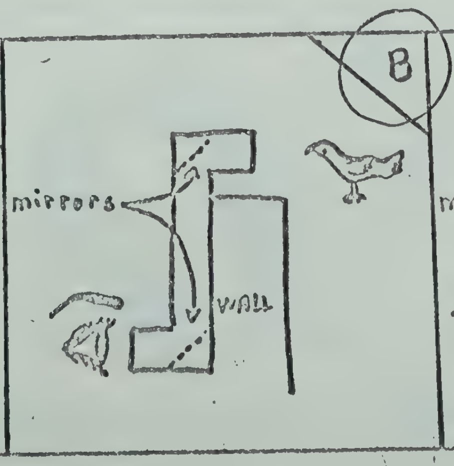

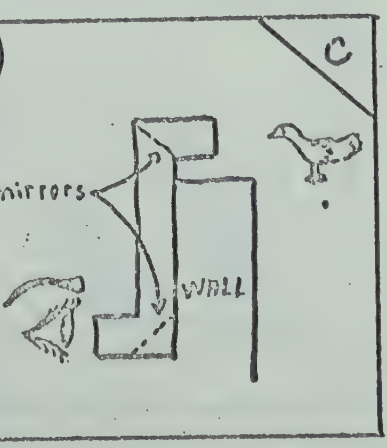

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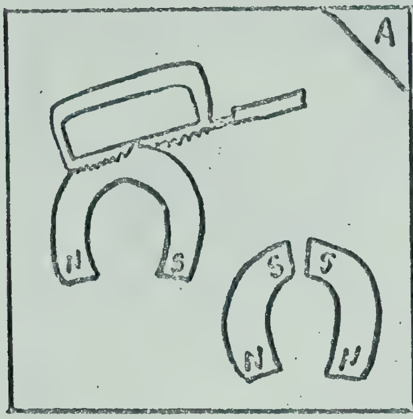

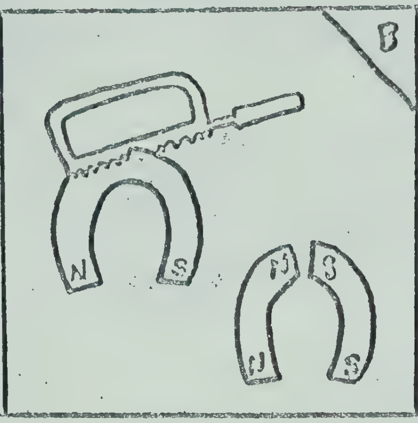

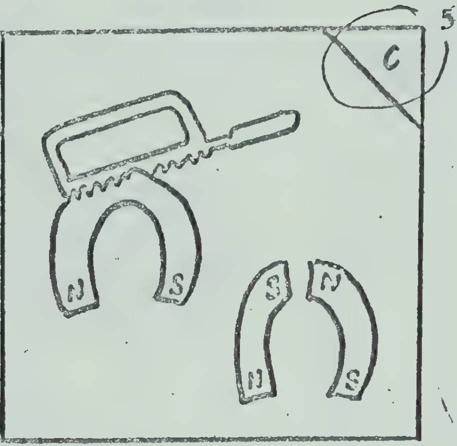

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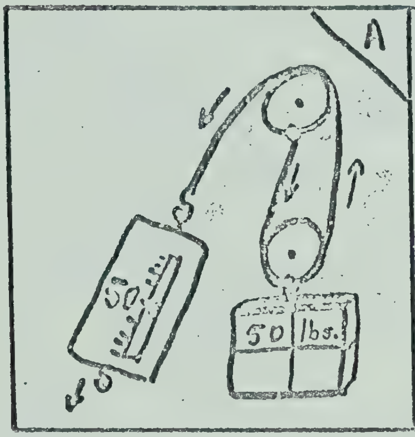

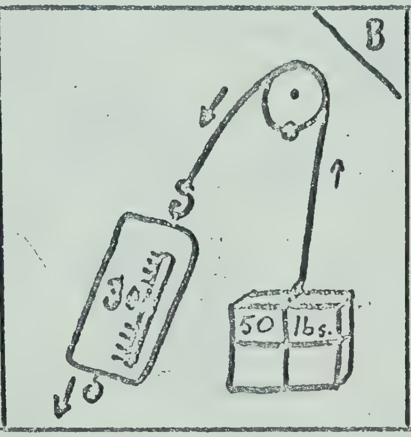

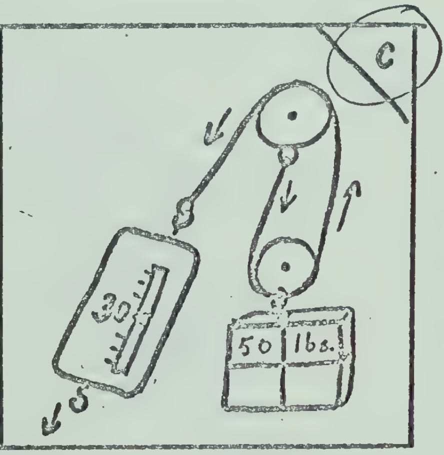

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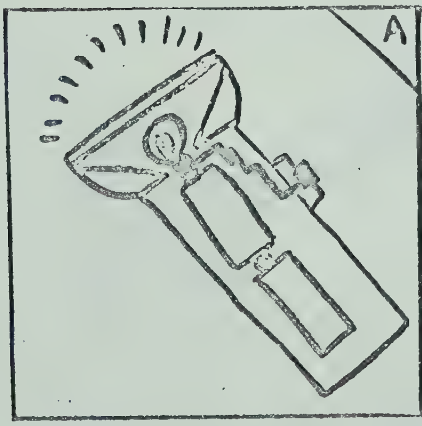

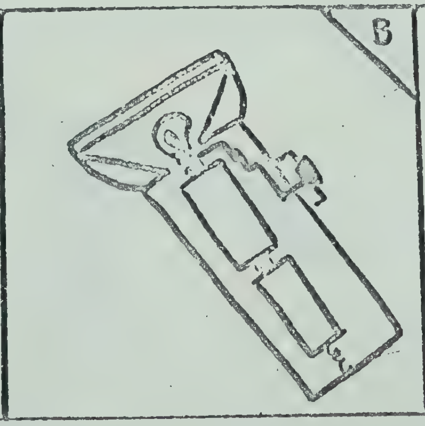

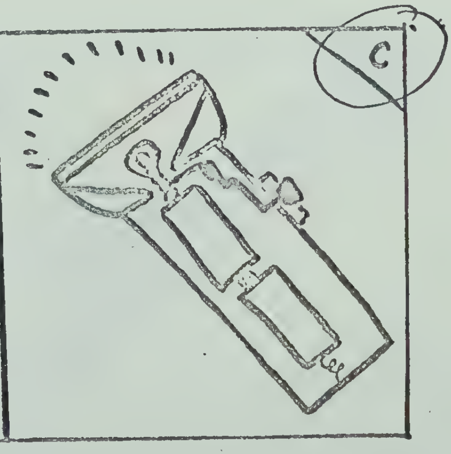

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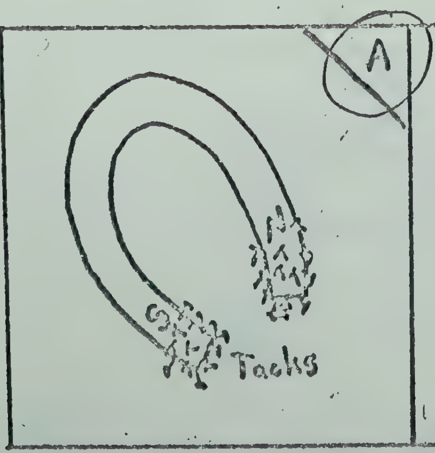

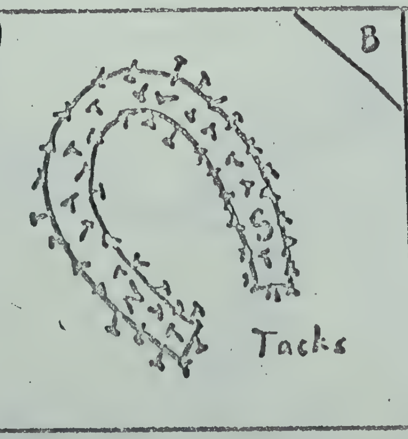

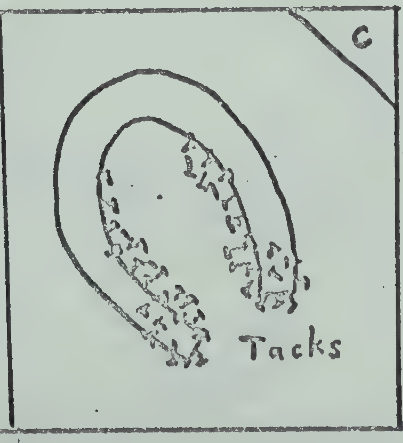

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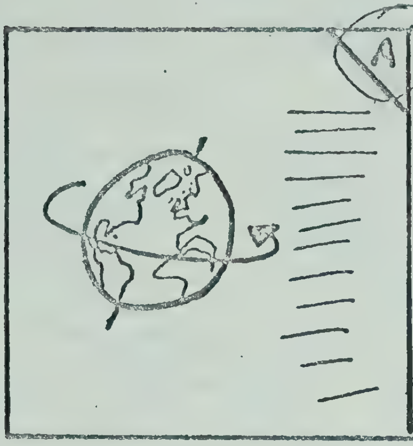

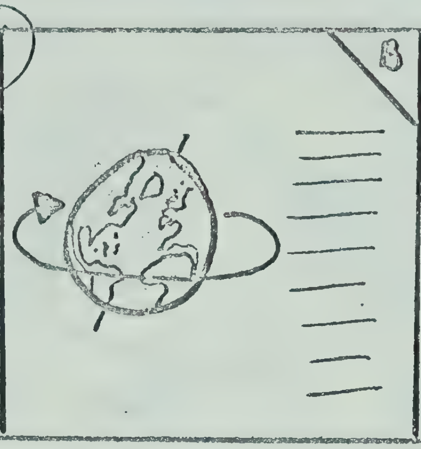

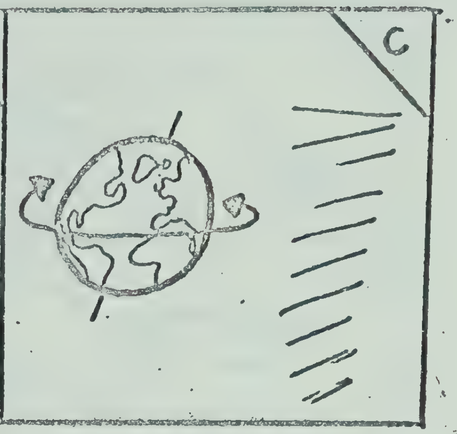

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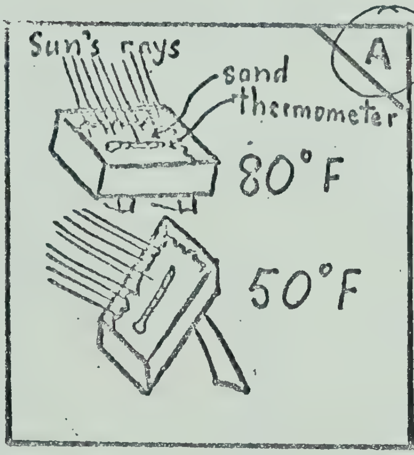

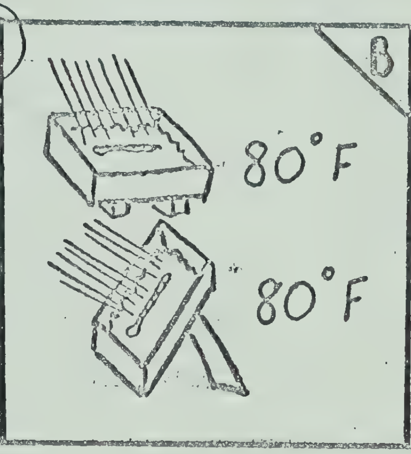

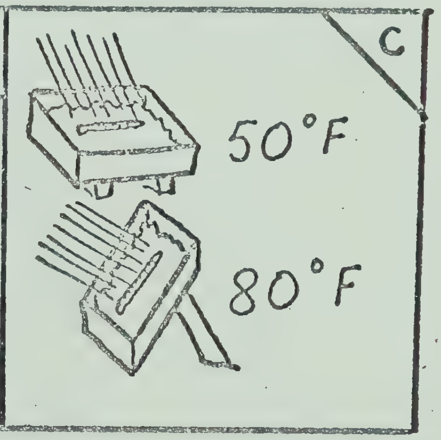

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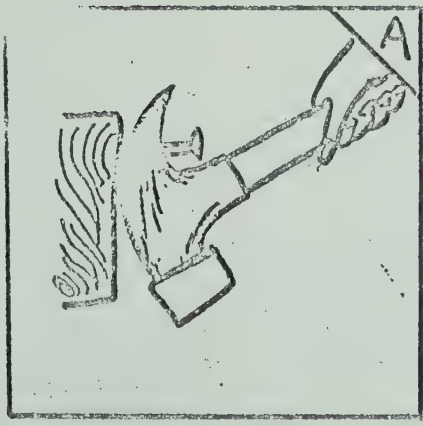

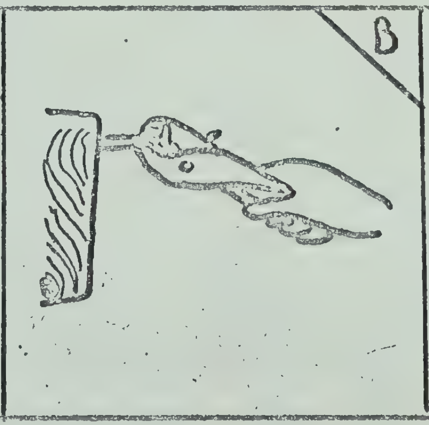

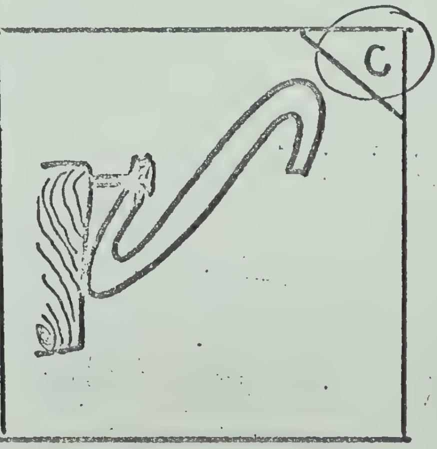

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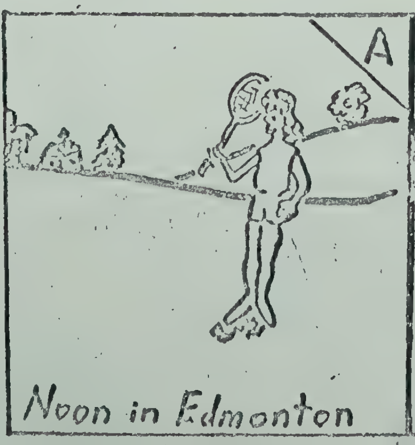

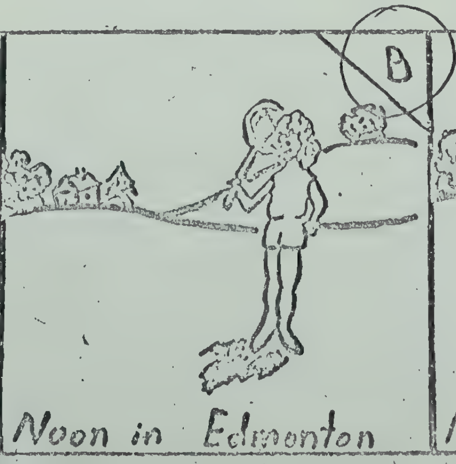

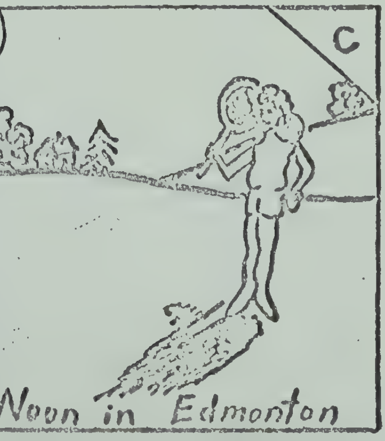

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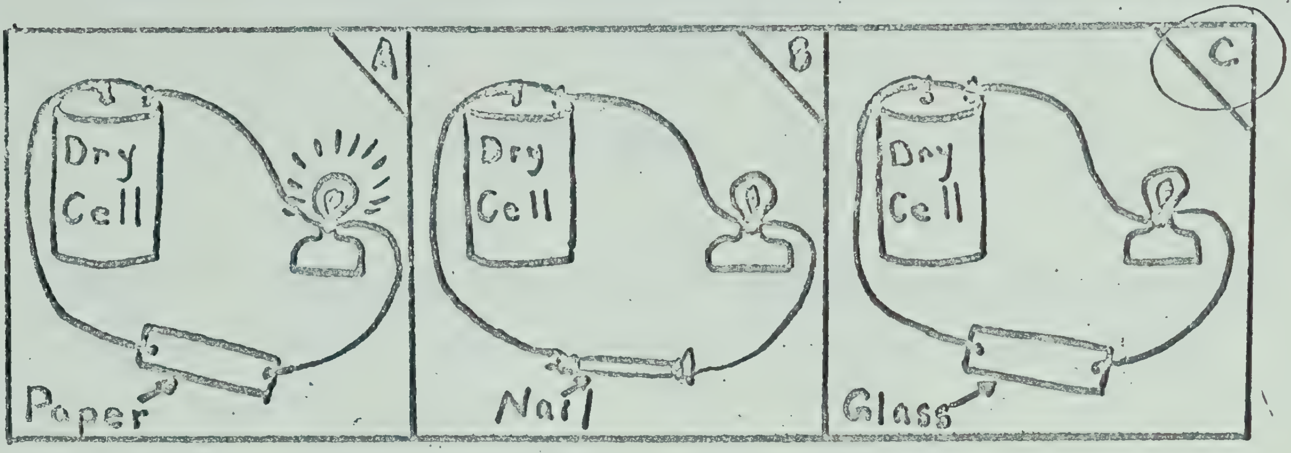


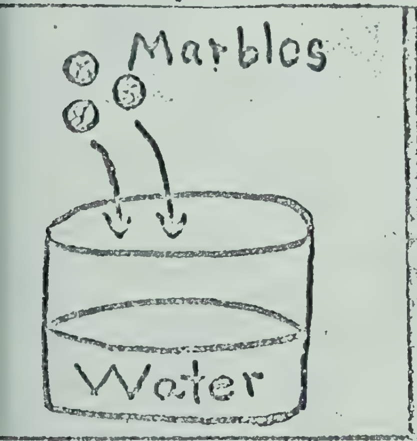
SECTION TWO

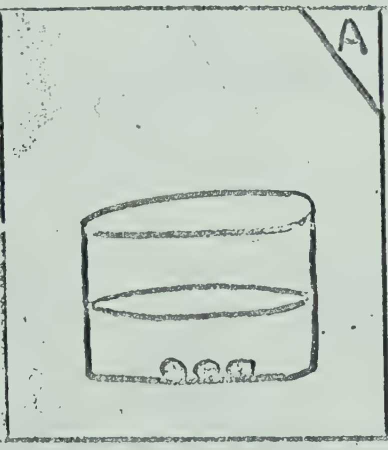
Continue through the following 15 questions in the same way you did those in SECTION ONE. Place your answers on the answer sheet, starting with number 26.

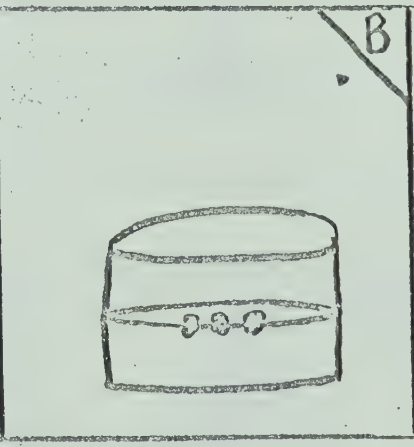
In each of the following questions, the first picture will show something happening or about to happen. Pictures A, B, or C will show the possible results.

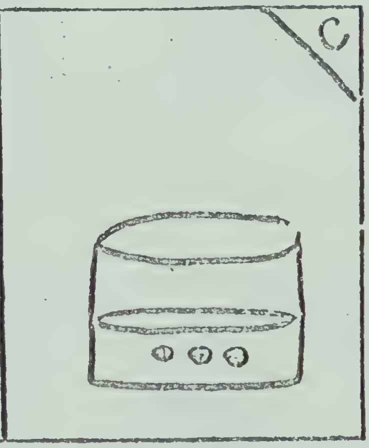
Here are two sample questions,

Example 137



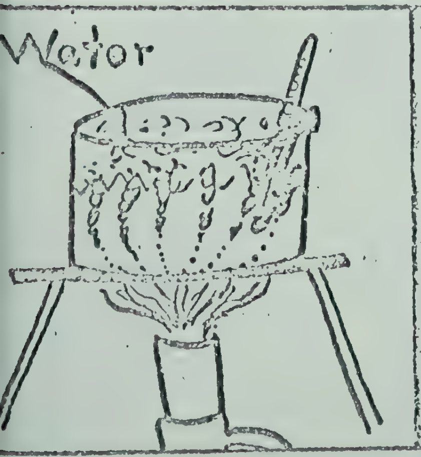


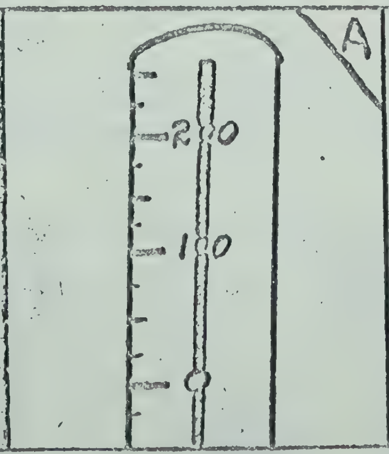


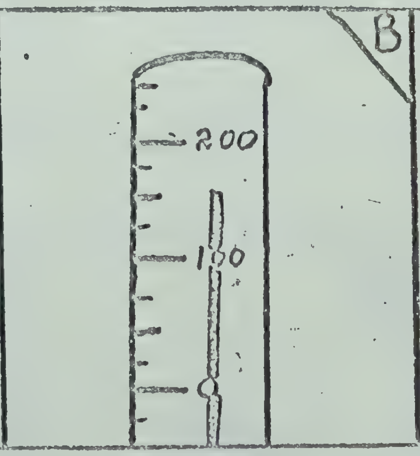


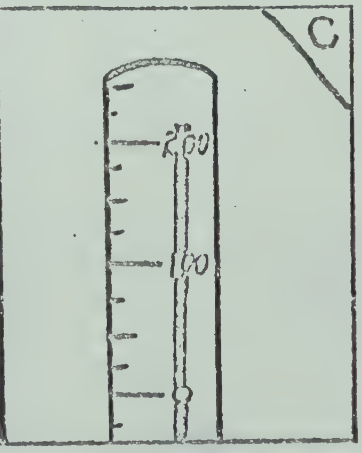
Beside #137 you should have marked A like this A 1

Example 138





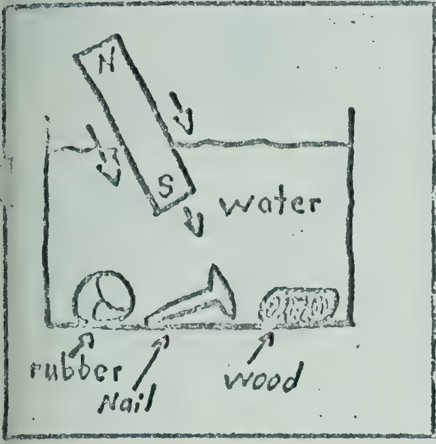


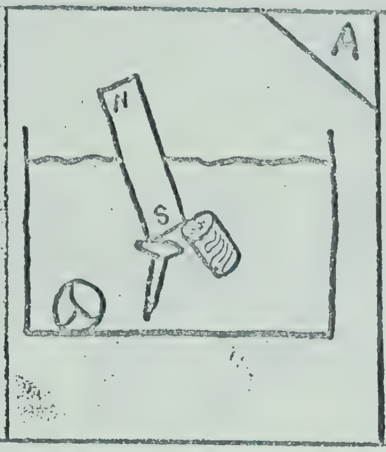


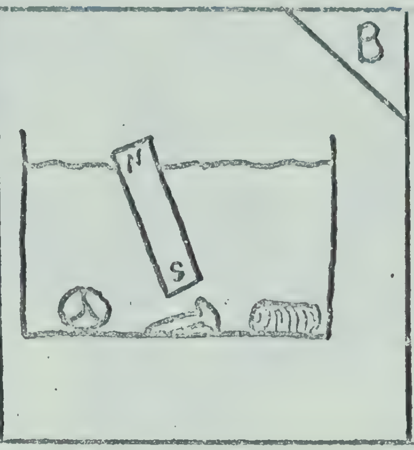
Place your answer on the answer sheet. Which answer did you choose?

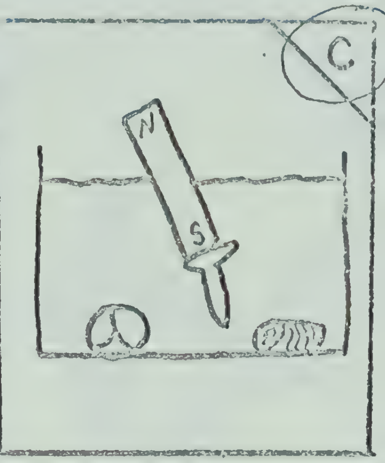
DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

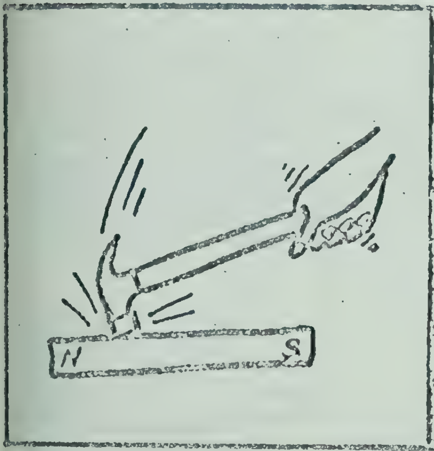
PLACE NO MARK ON THIS PAGE

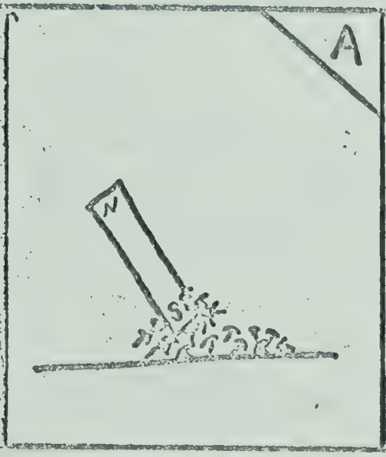


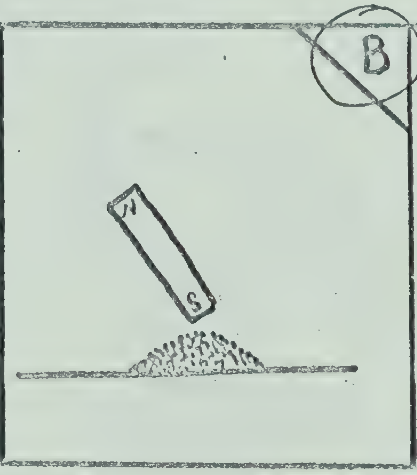


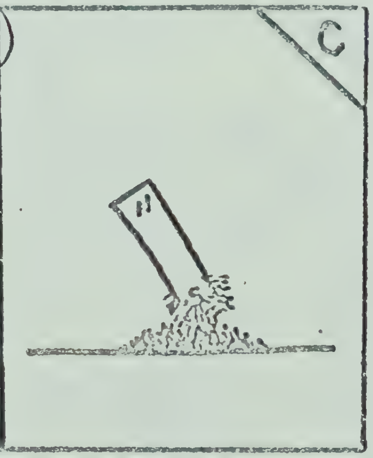


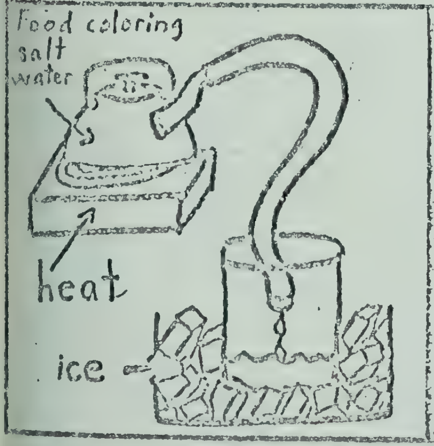


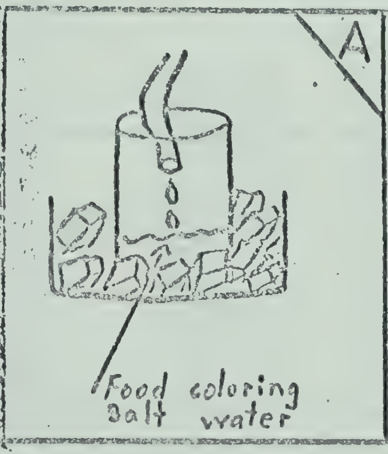


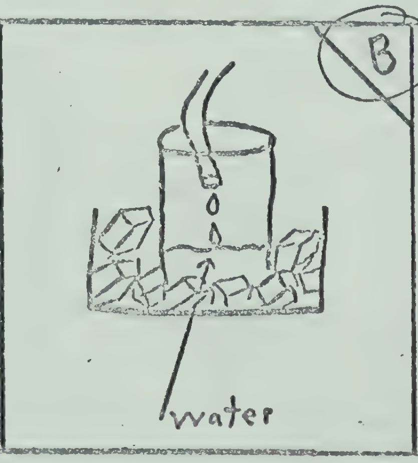


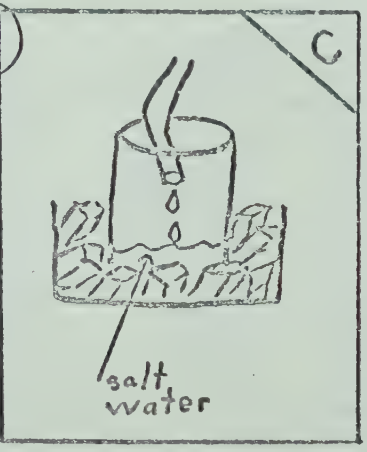


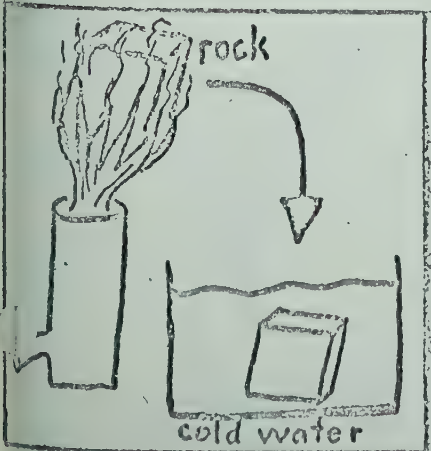


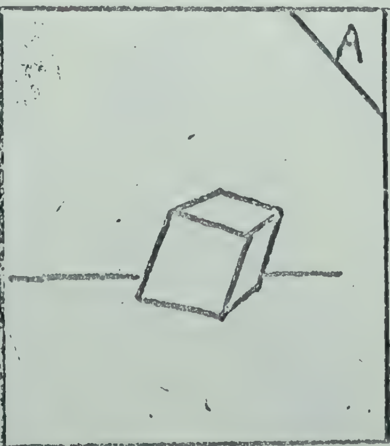


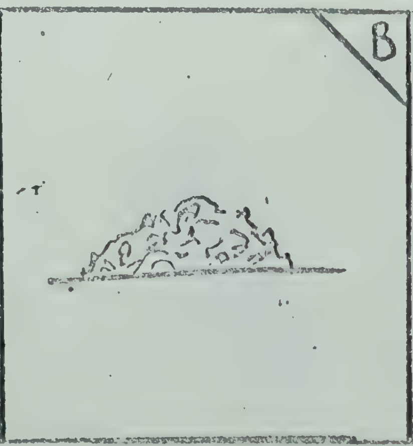


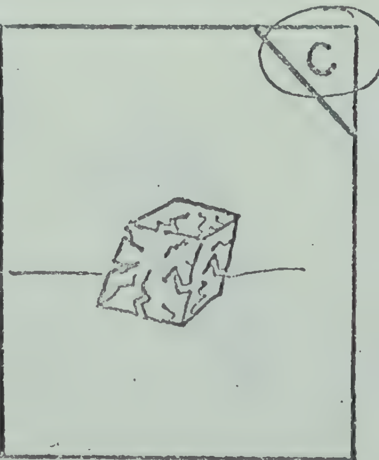












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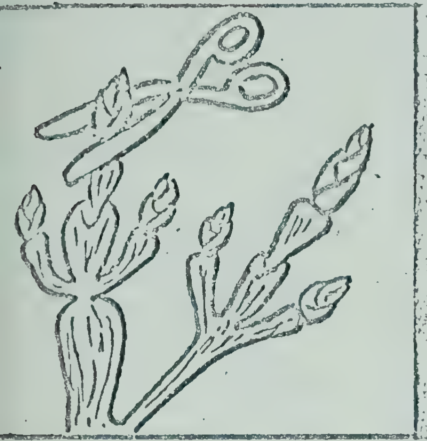

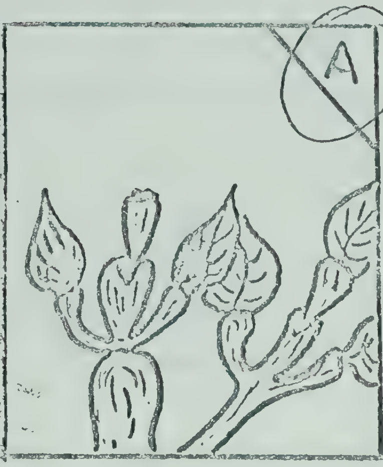

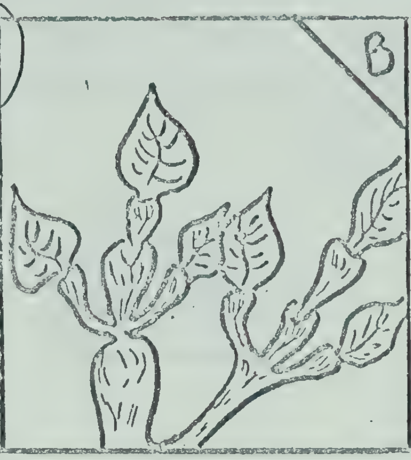

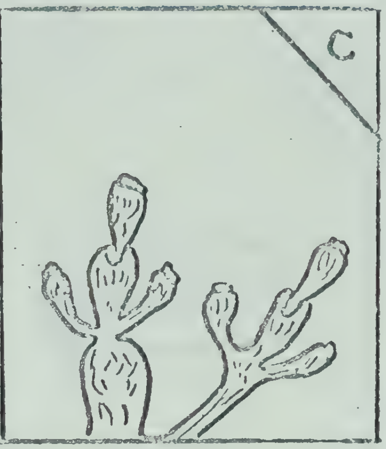

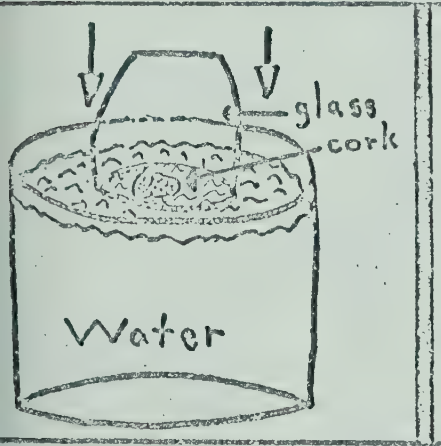

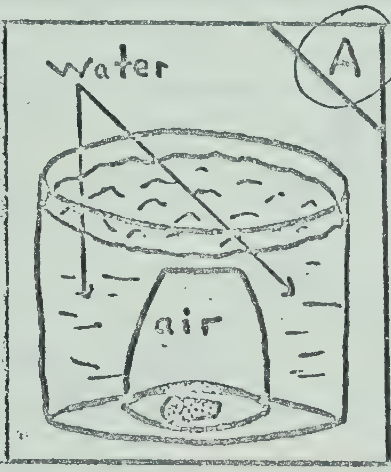

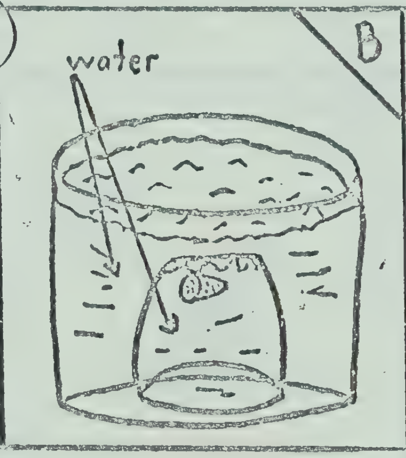

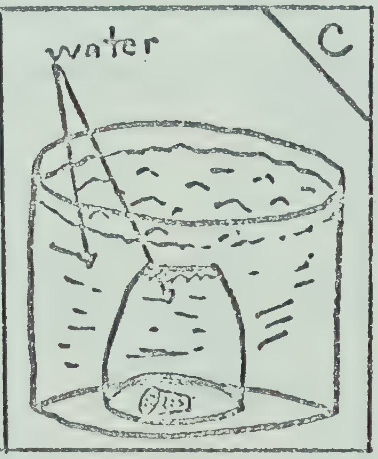

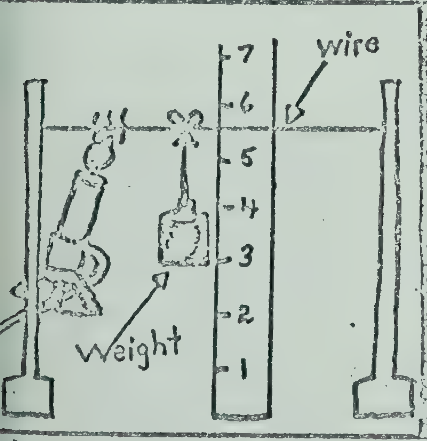

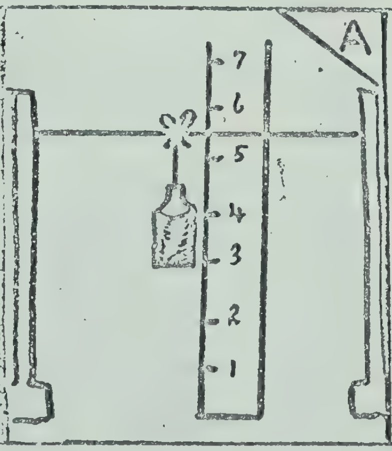

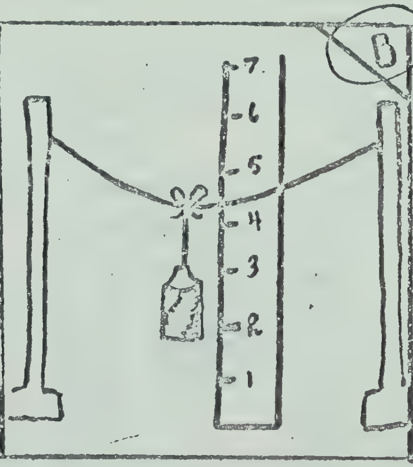

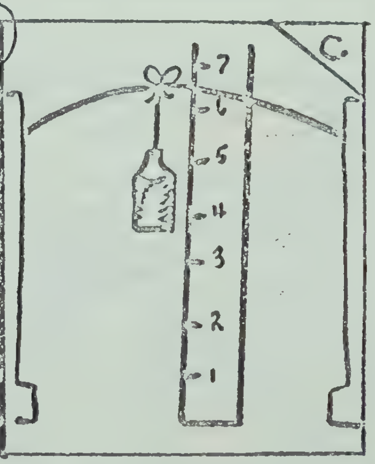

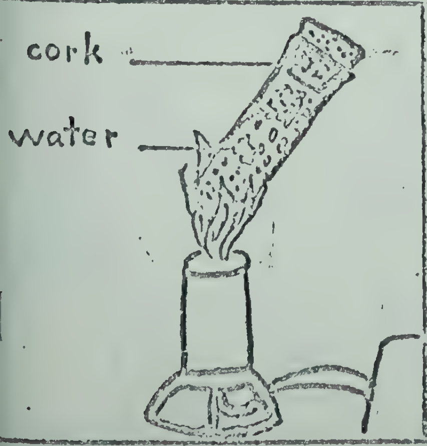

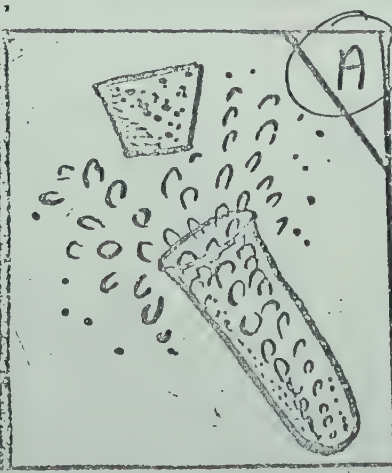

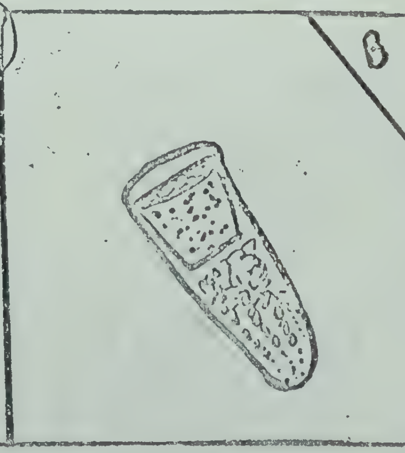

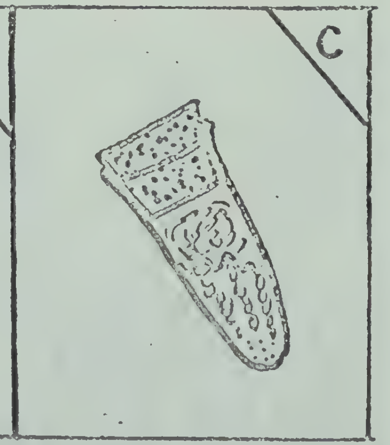

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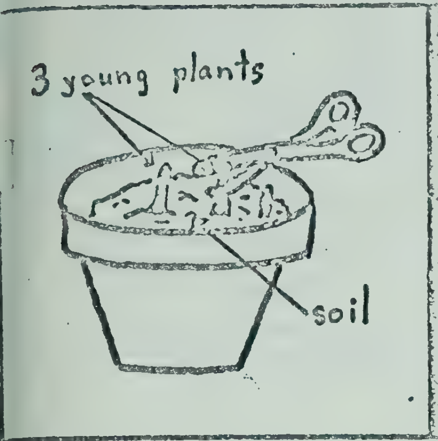

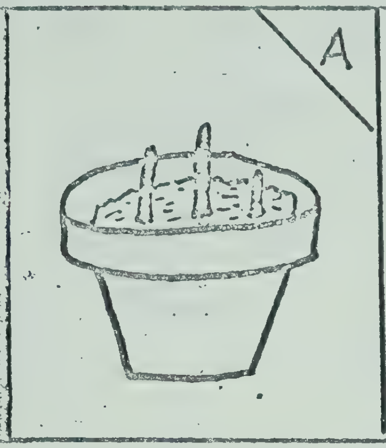

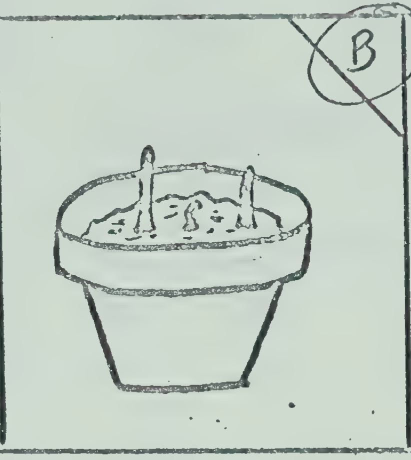

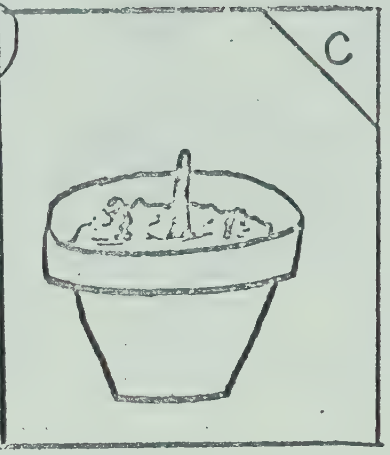

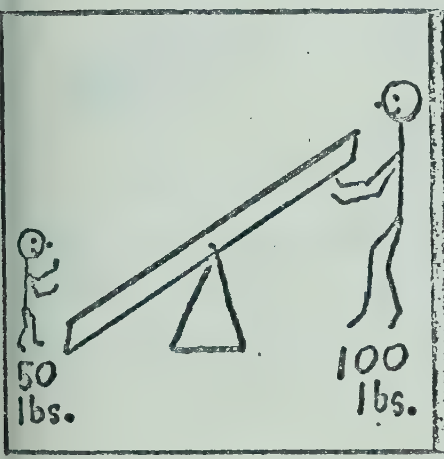
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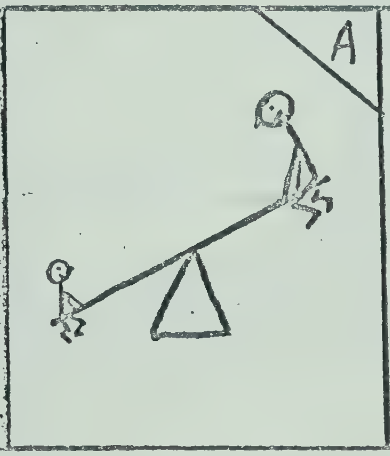

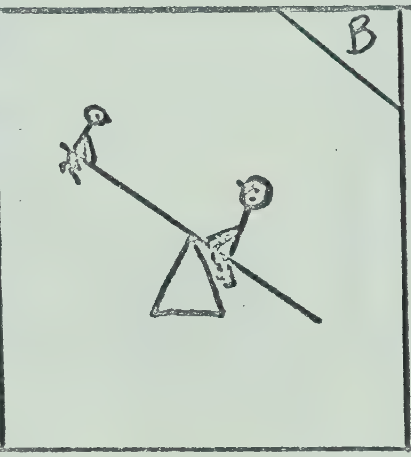

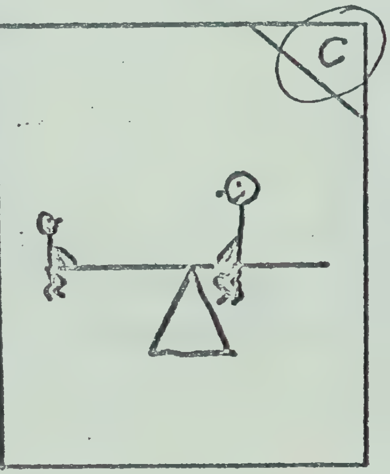

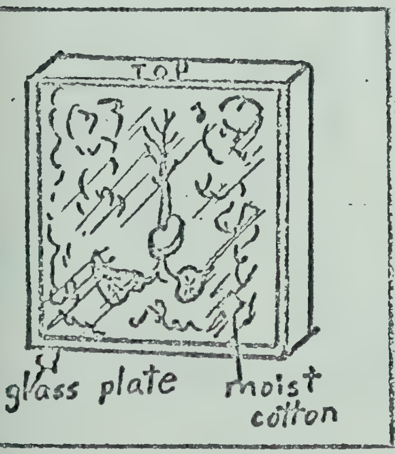

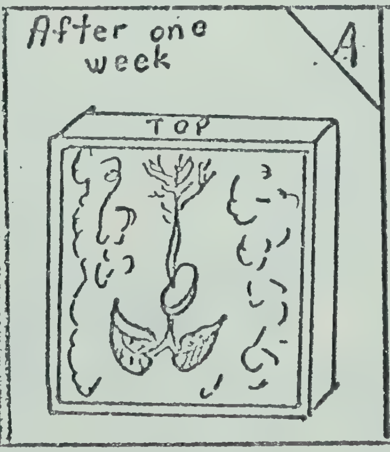

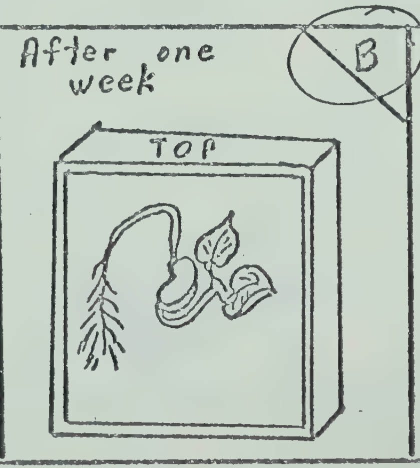

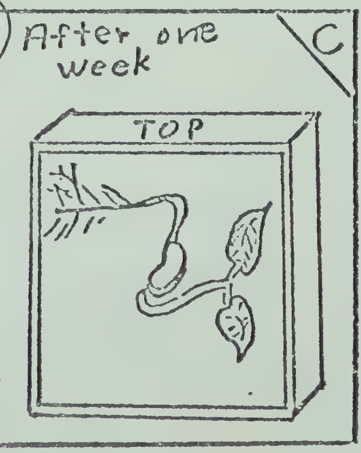

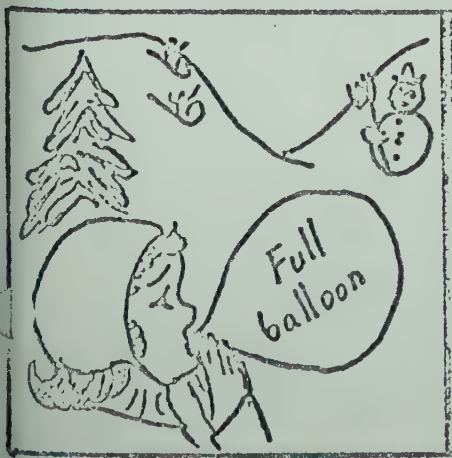

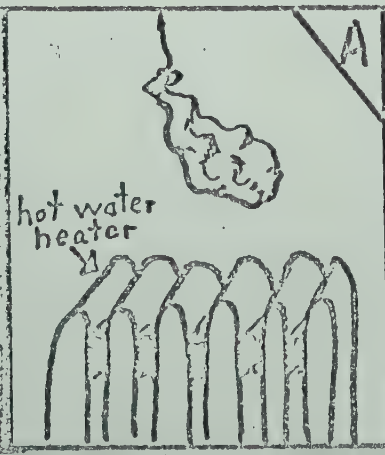

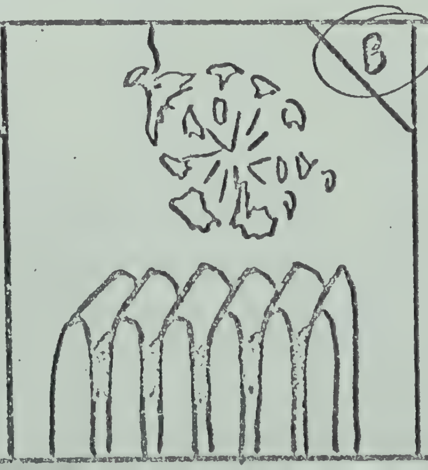

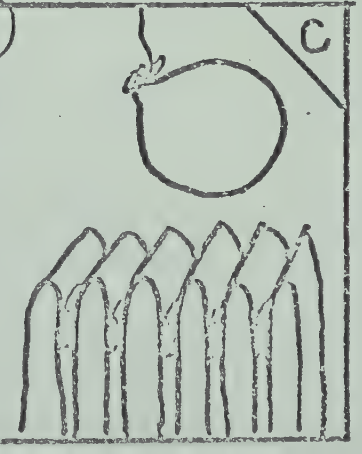

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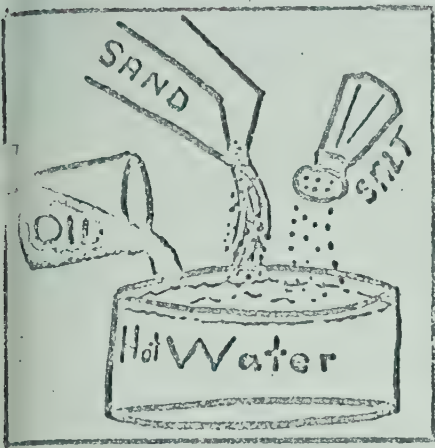

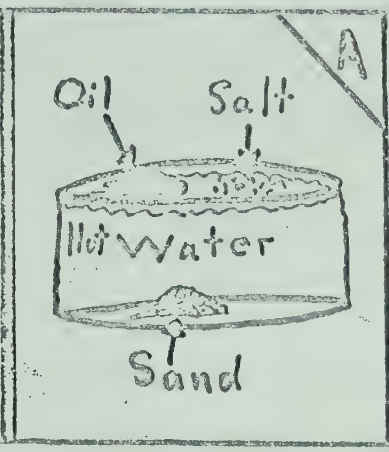

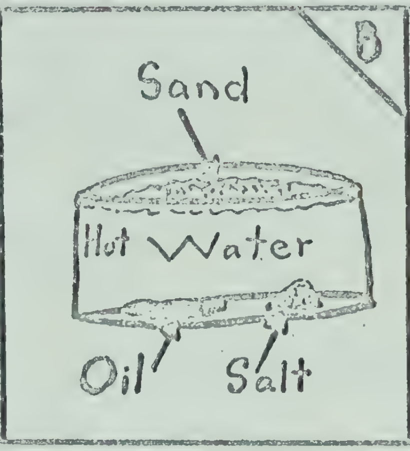

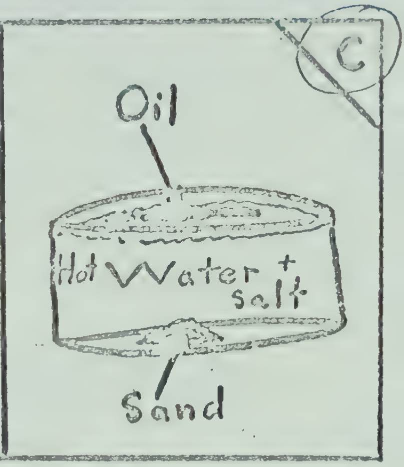

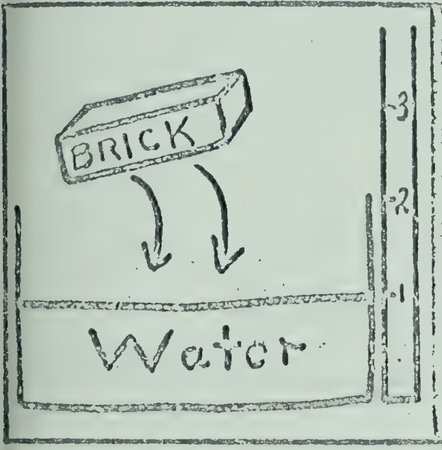

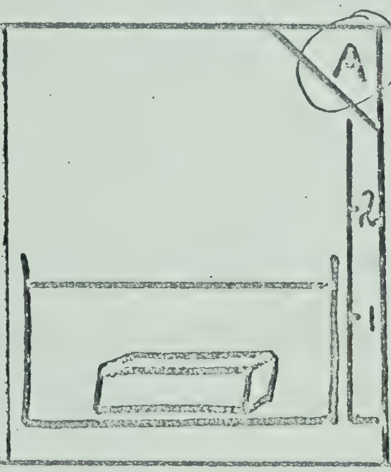

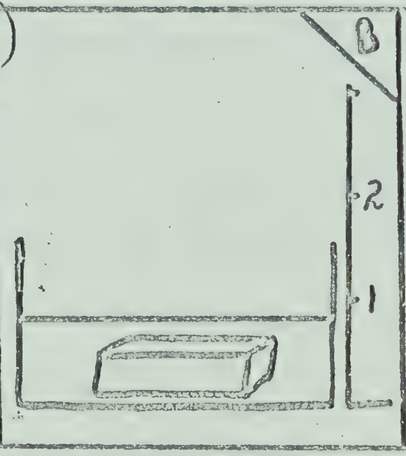

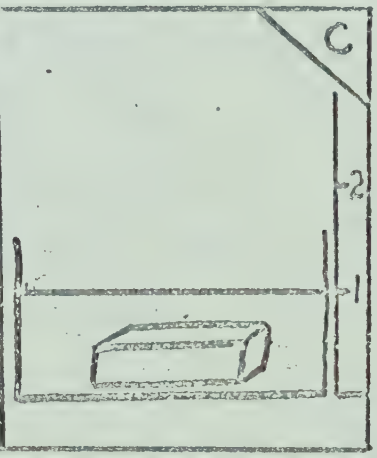

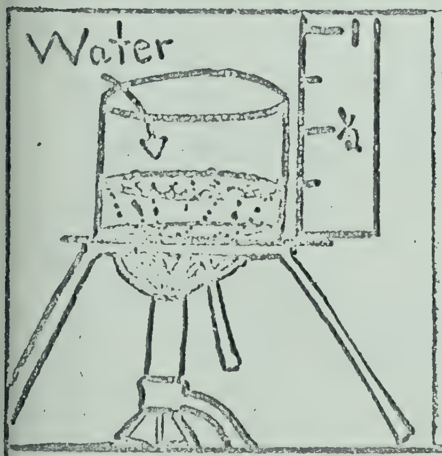

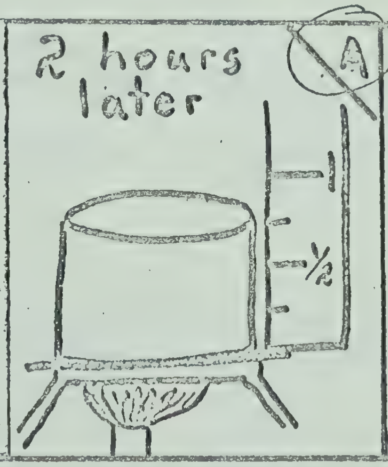

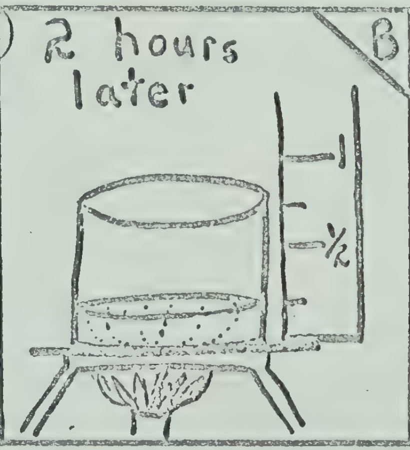

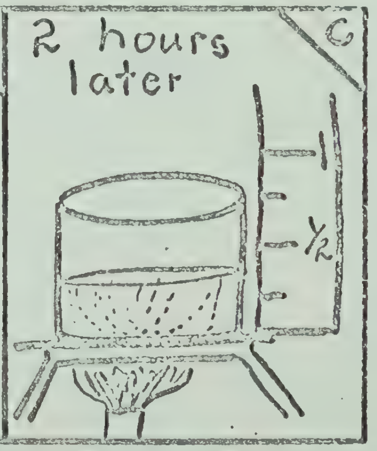

FORM 1 - INTERVIEWS

PICTORIAL SCIENCE TEST

SECTION THREE

Do not write in any way upon the pages of this booklet. Place your answers on the answer sheet in the same way you did in SECTIONS ONE and TWO. Start on number 40.

In each of the following 22 questions you will find three things at the top which are alike in one main way. At the bottom of the question are three other things (A, B, C). Only one of A, B, or C could be put with the group at the top and belongs with them. You are to discover the rule by which the top ones are grouped and then choose one of A, B, or C.

Two sample questions are on the following page.

Example 139

B 2 is the answer because the group members and the walnut are all parts of plants that we eat.

Example 140

Which answer did you mark on your answer sheet?

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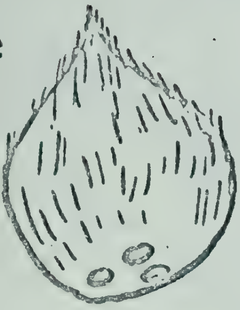
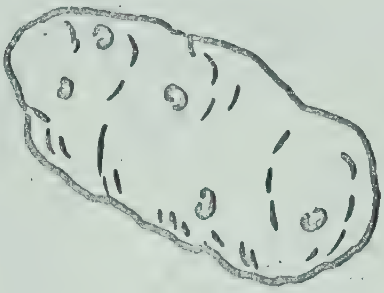
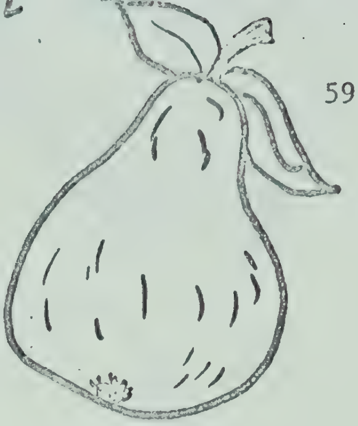
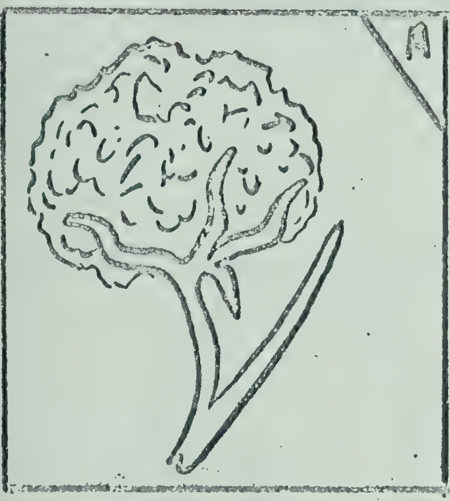
DO NOT MARK THIS PAGE

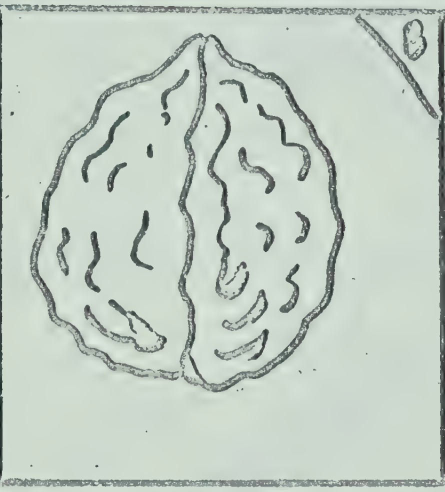
xample
39

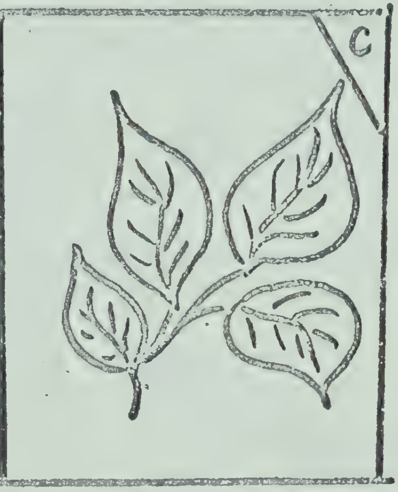












xample
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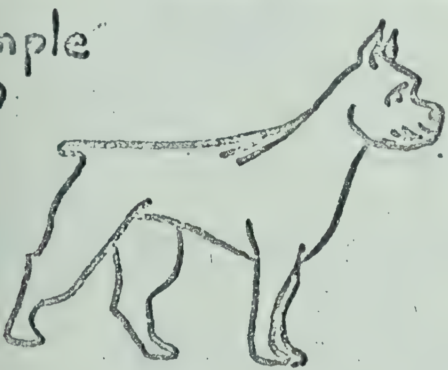

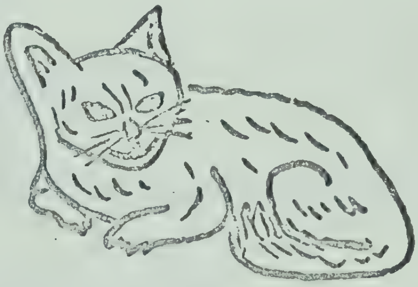

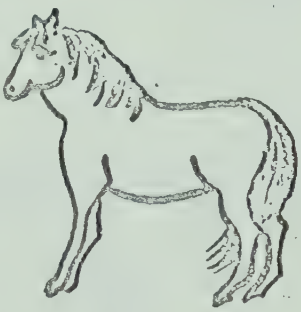

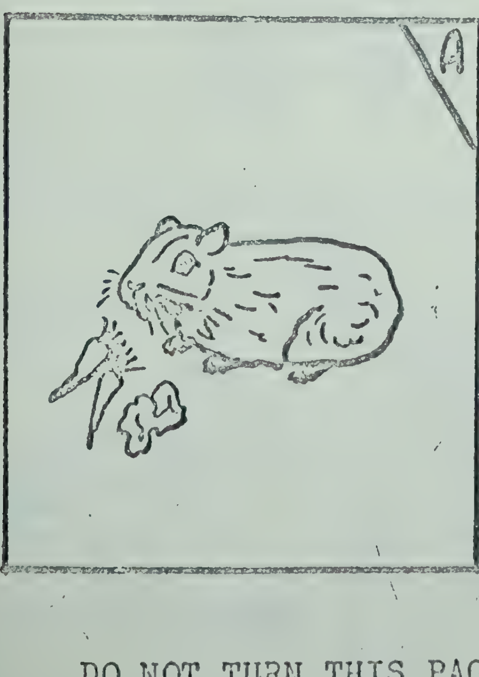

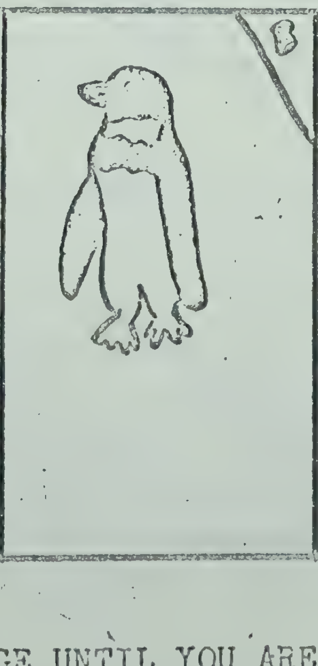

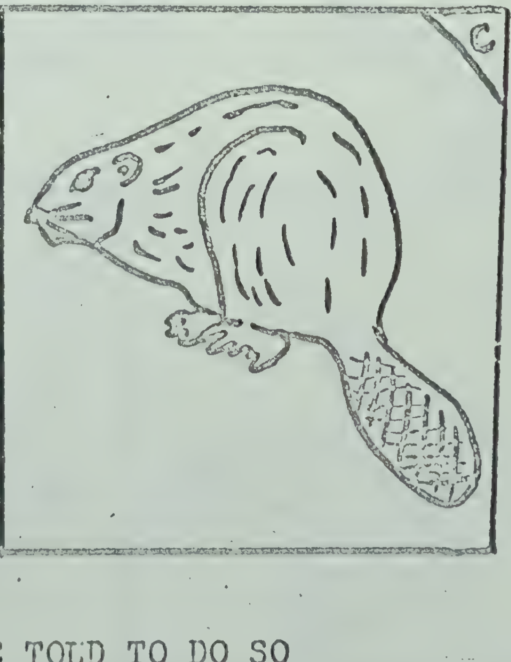

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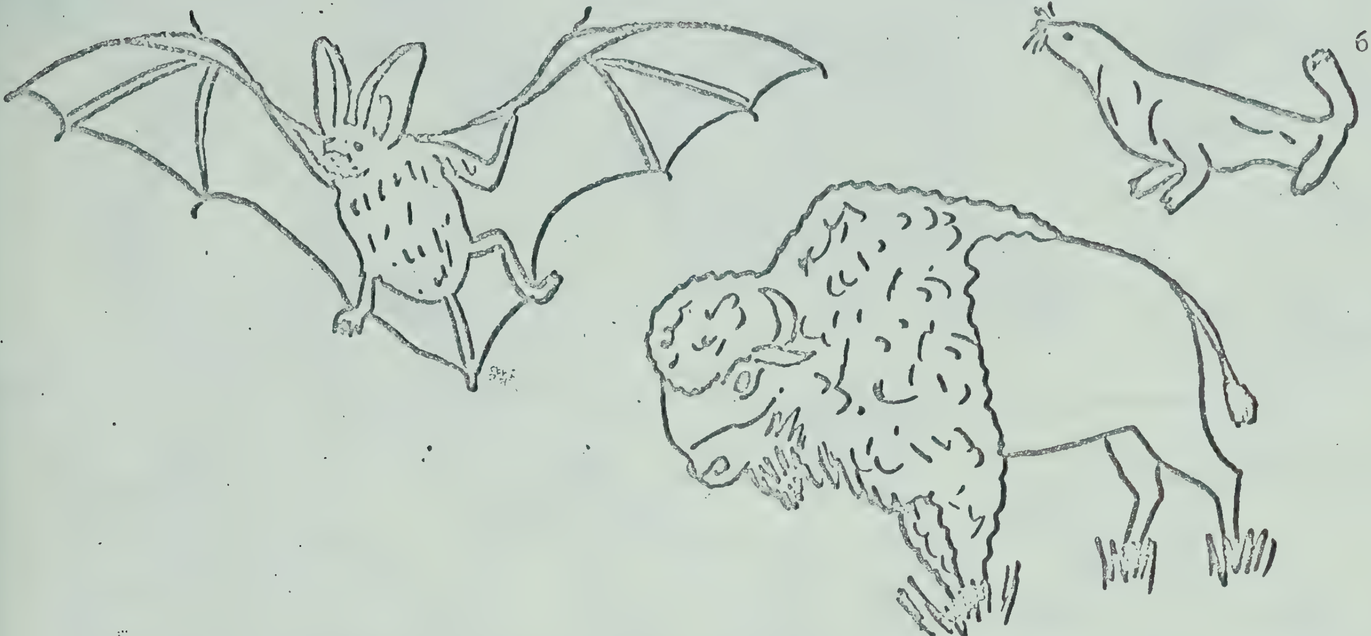

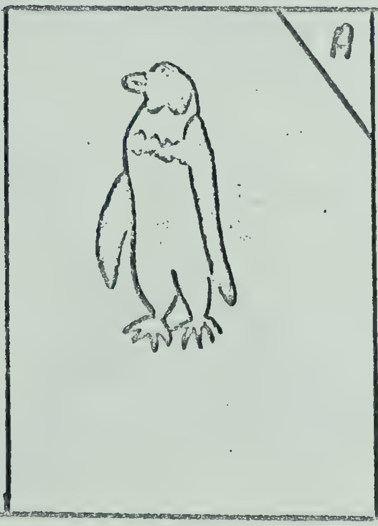
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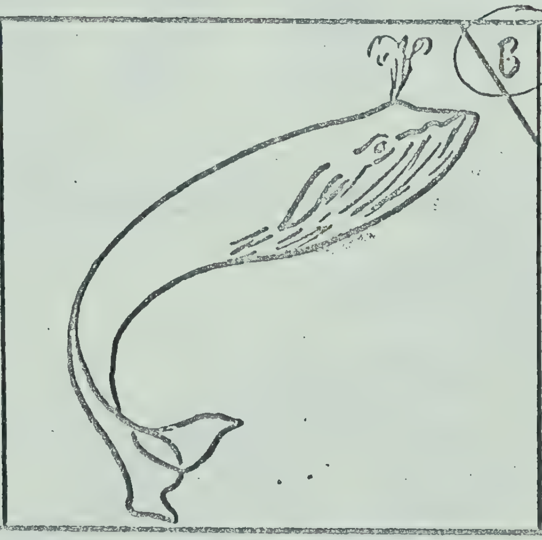
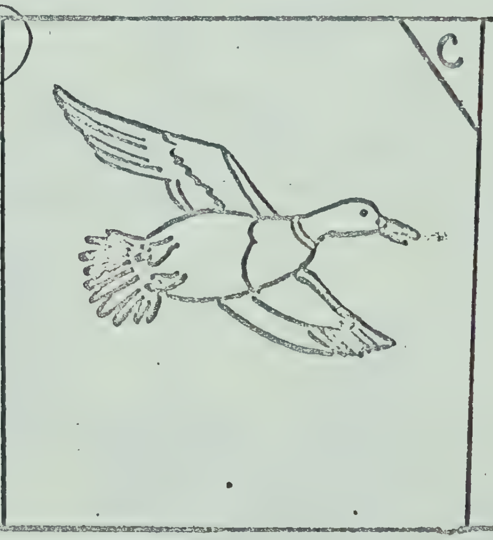

[✓ B]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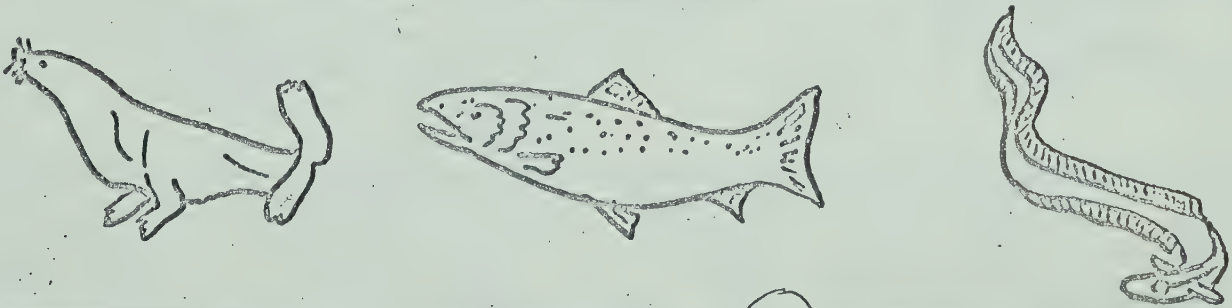

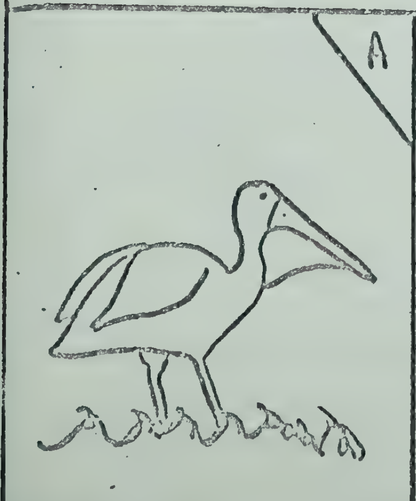
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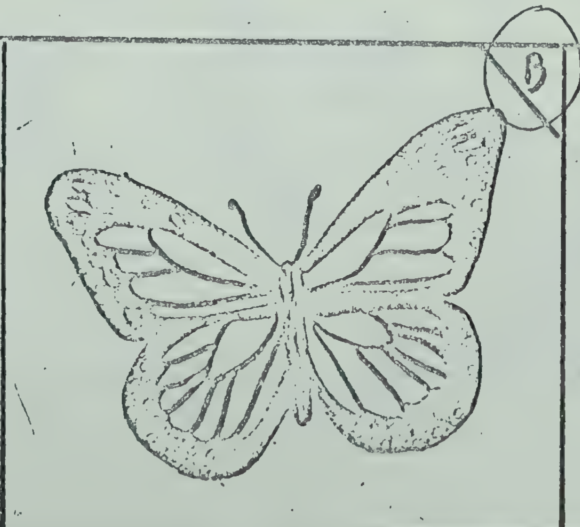
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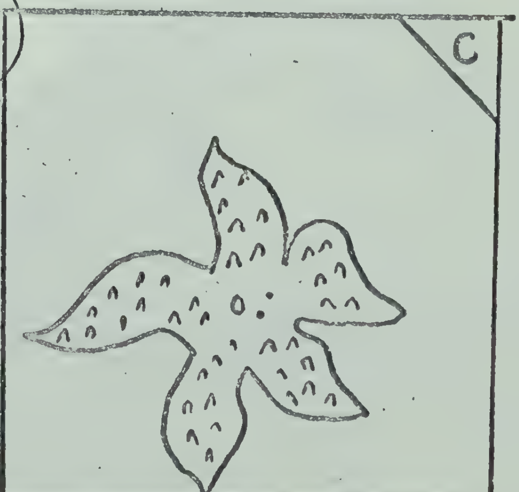
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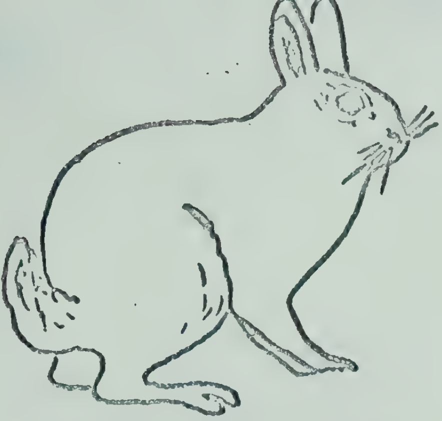

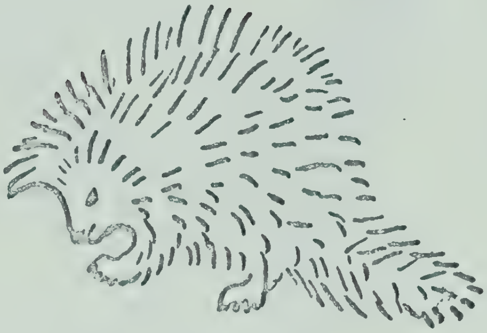

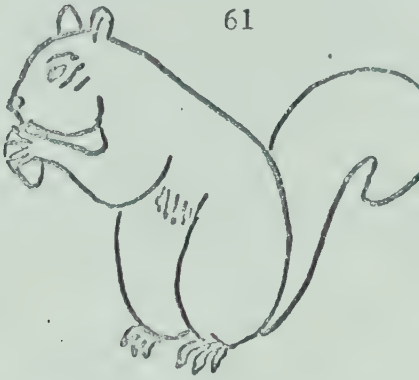

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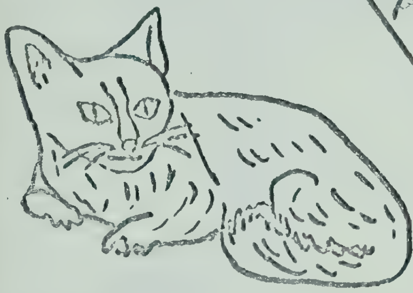

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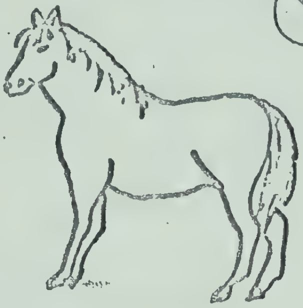

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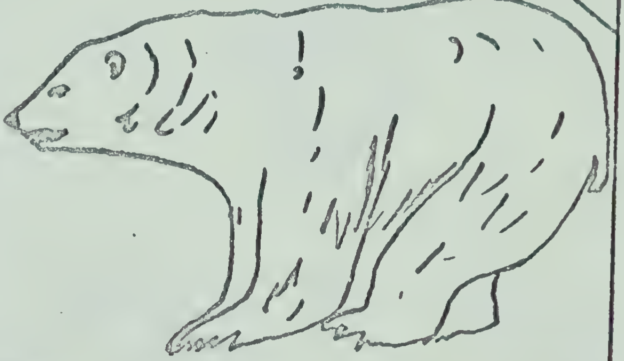

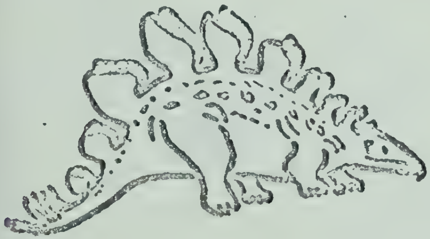

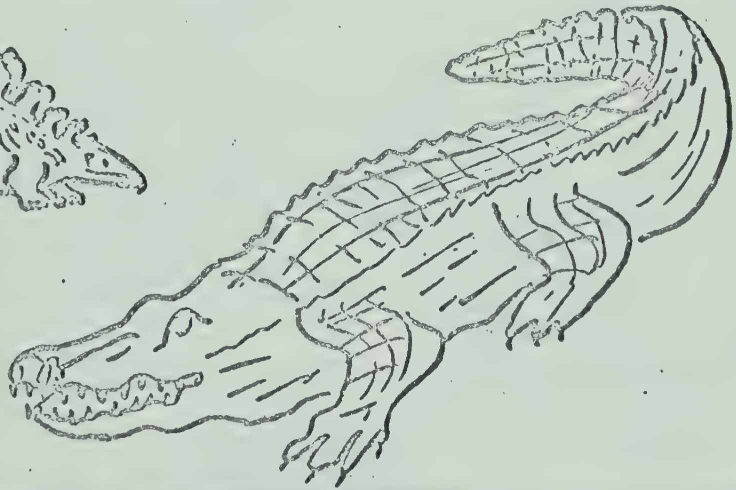

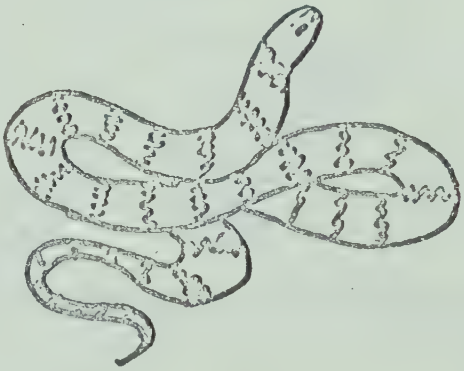

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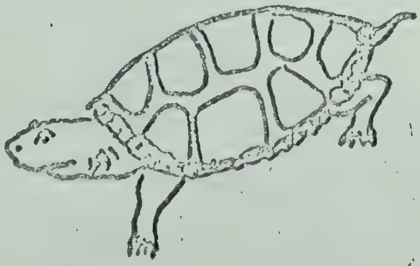

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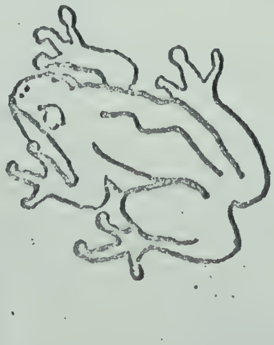

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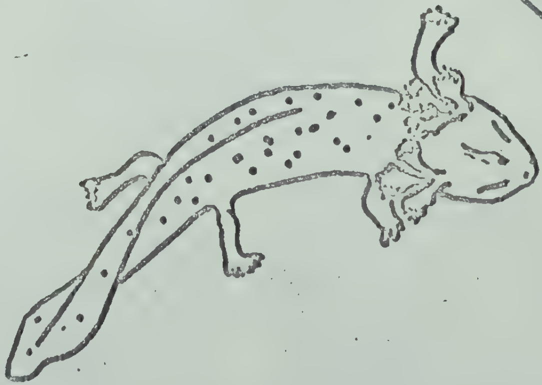

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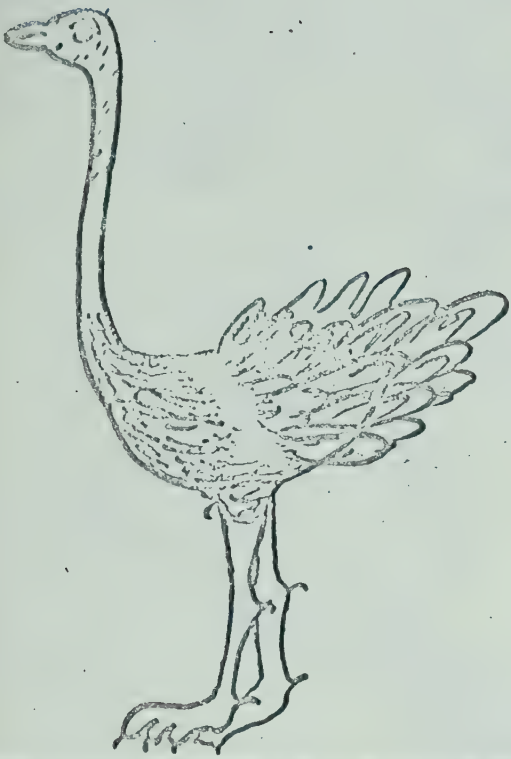

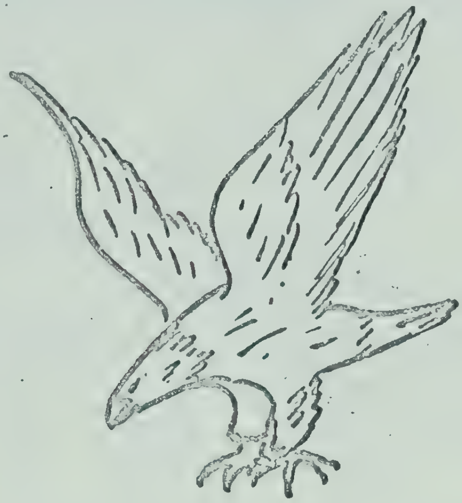

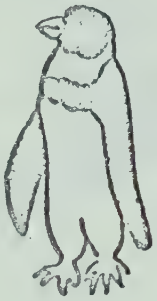

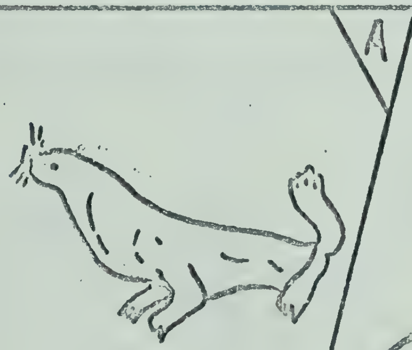

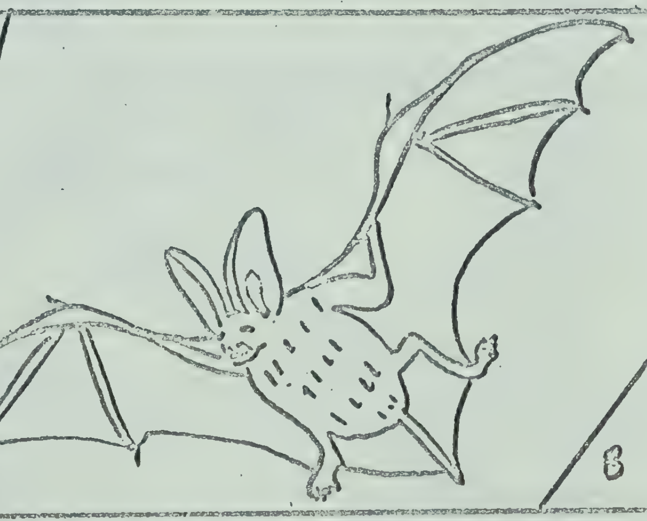

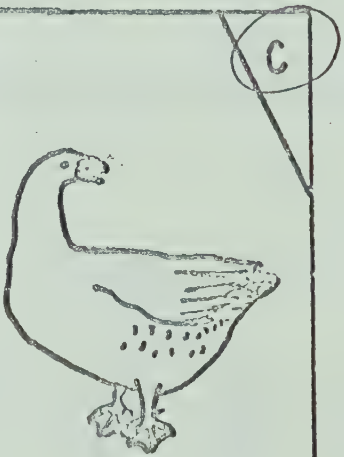

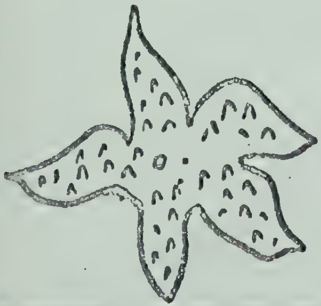

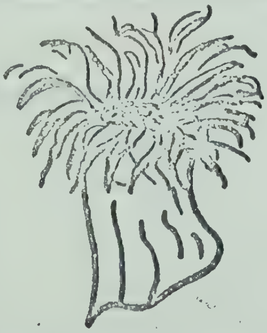

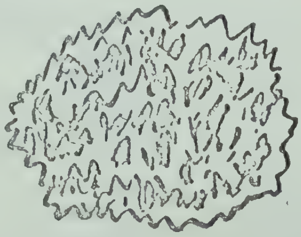

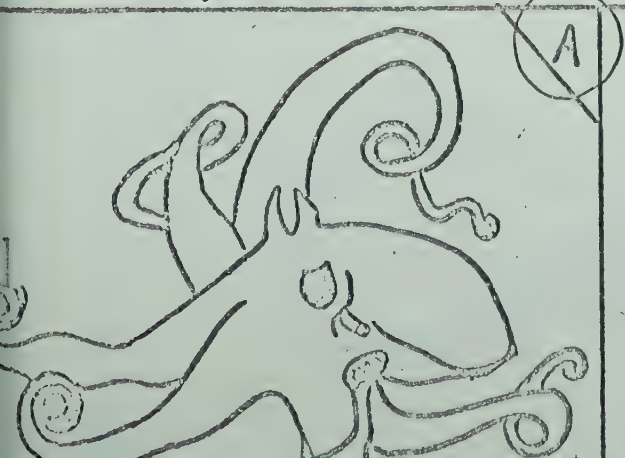

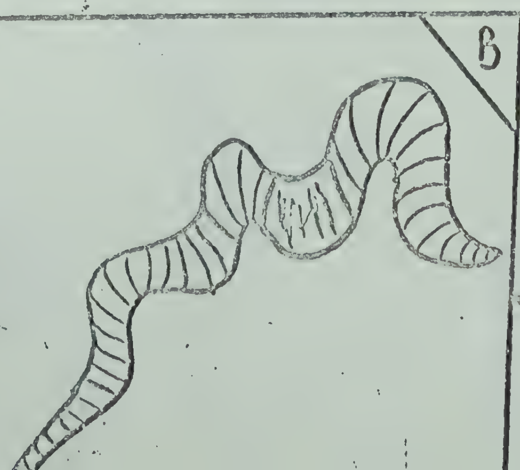

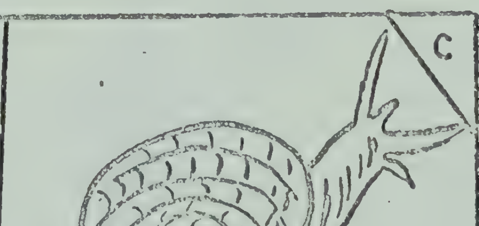

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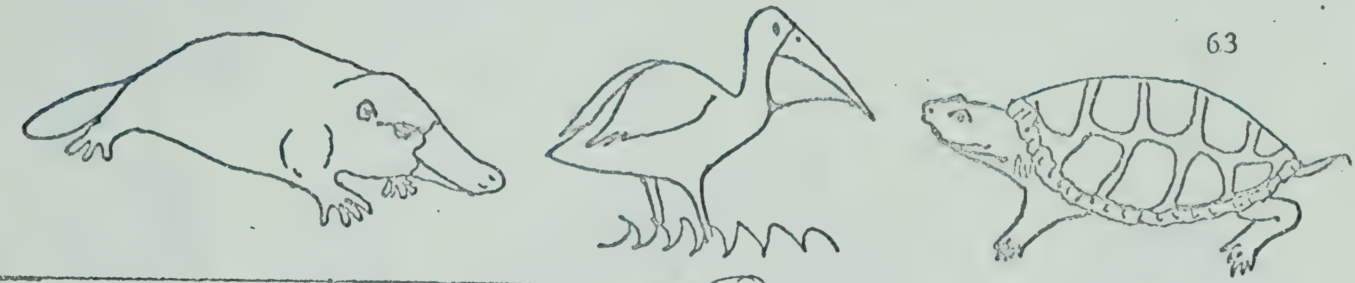

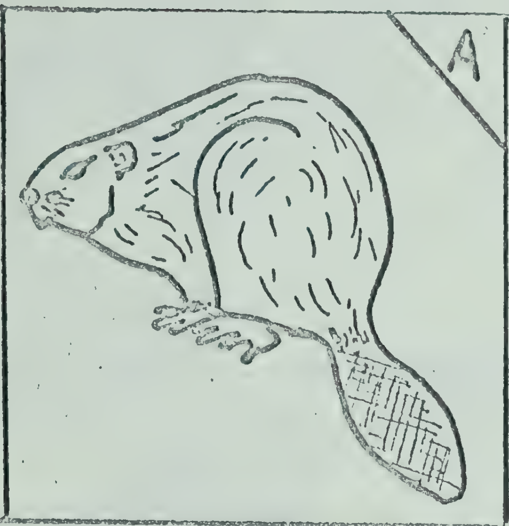
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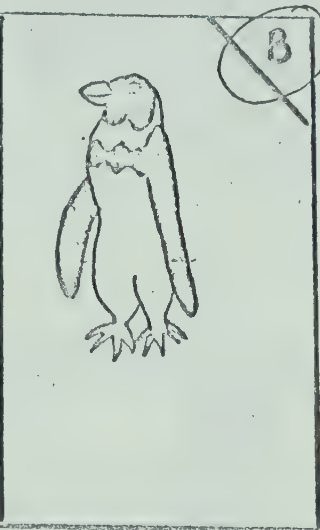
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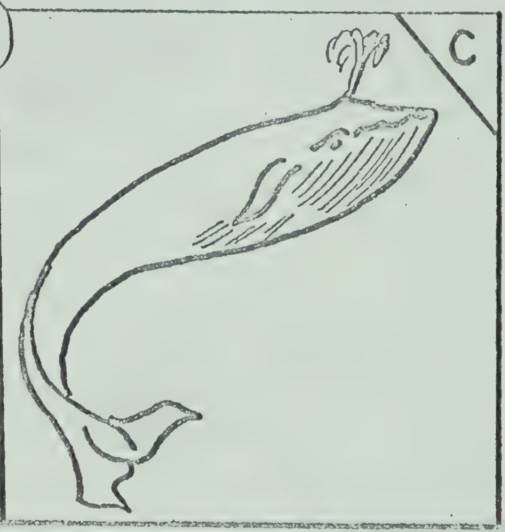
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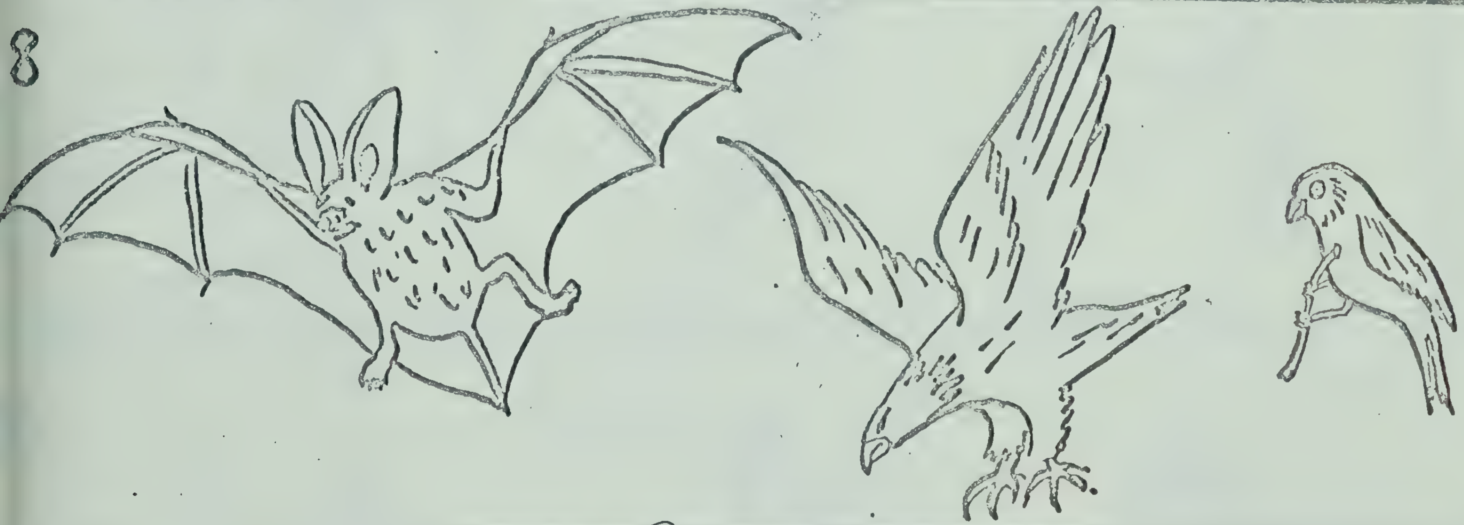

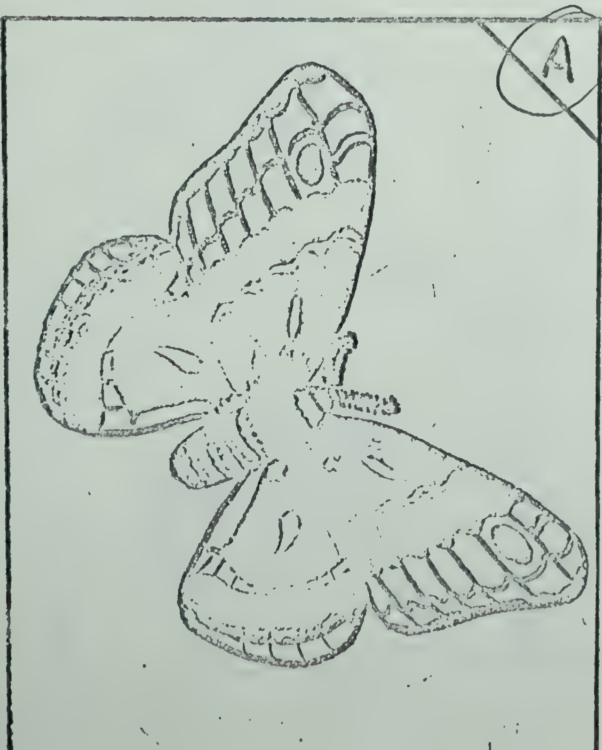
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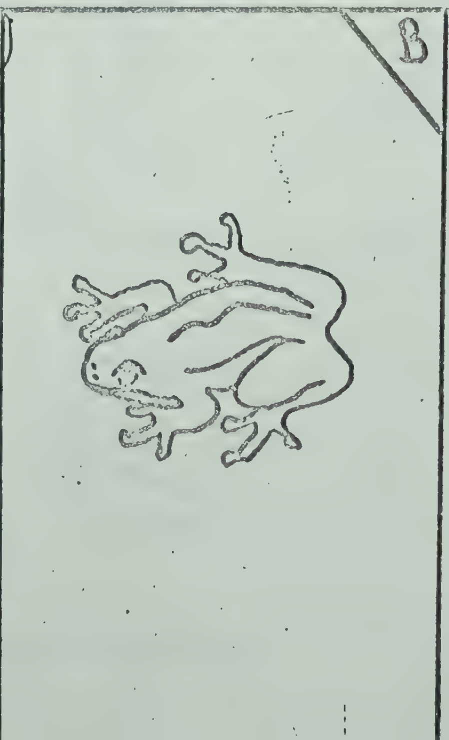
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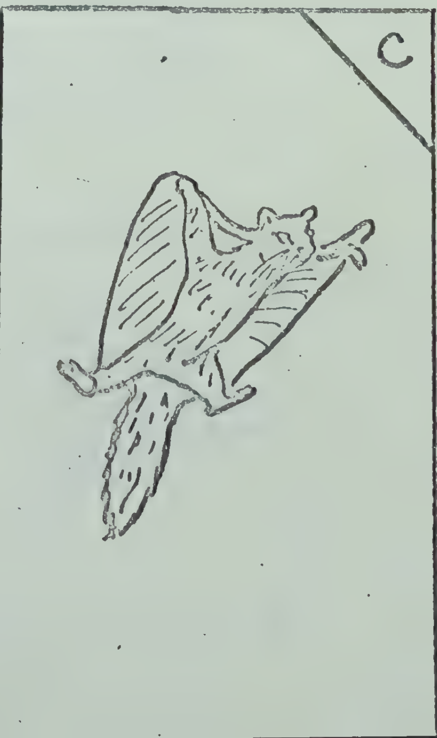
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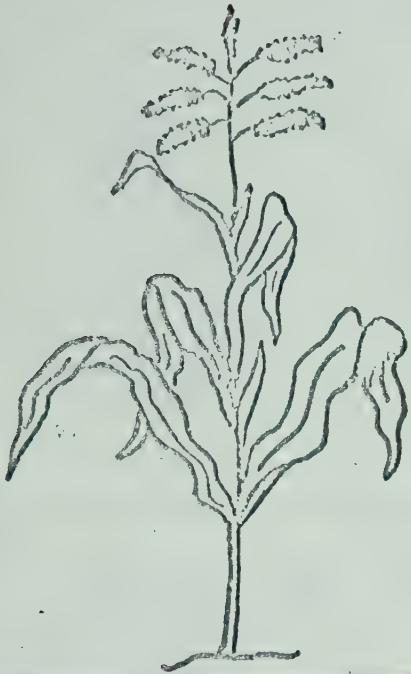

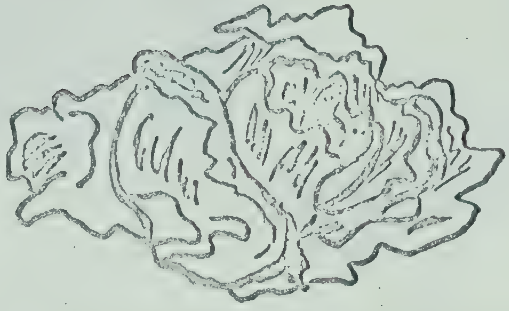

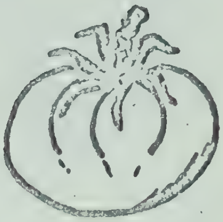

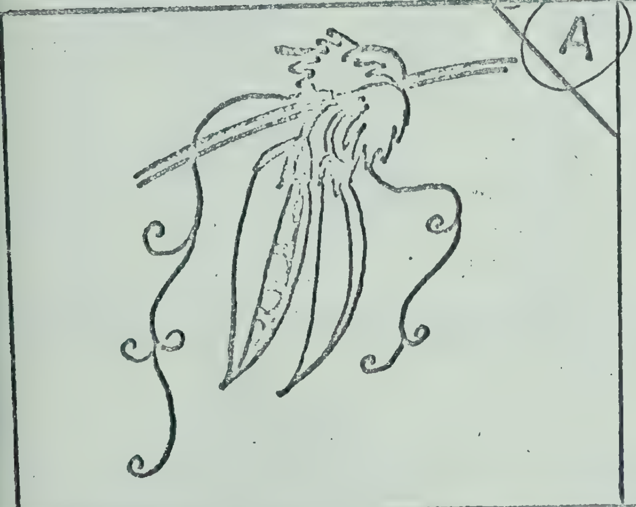
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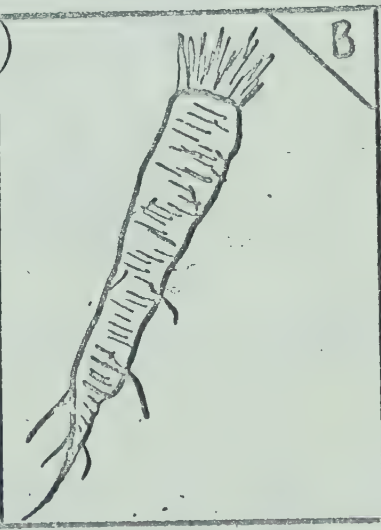
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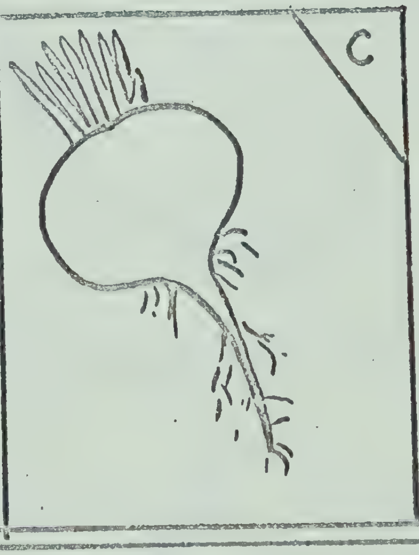
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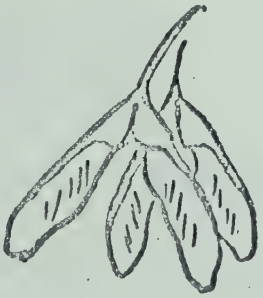

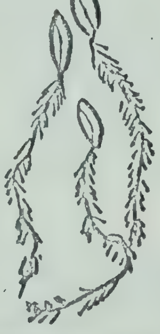

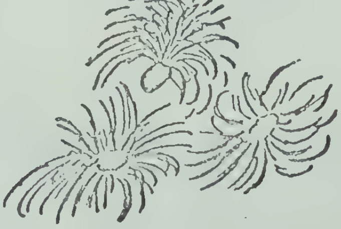

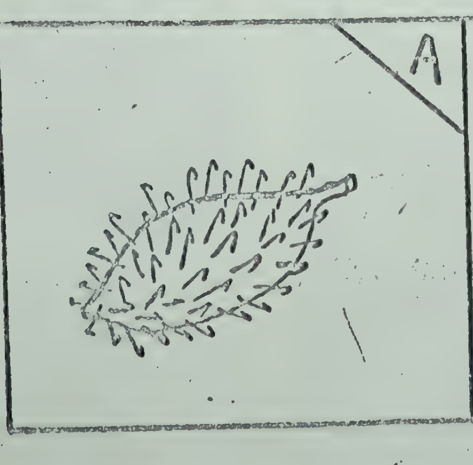
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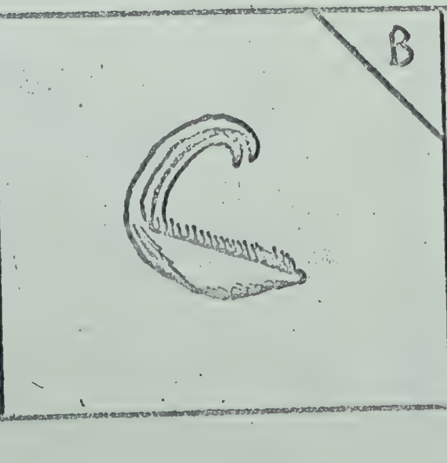
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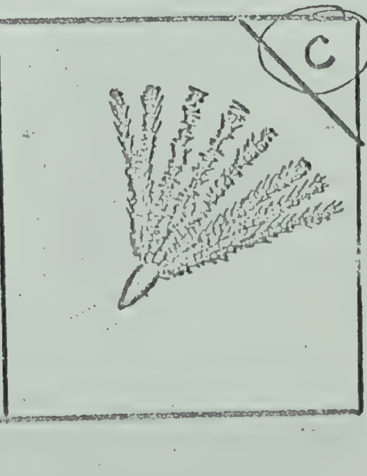
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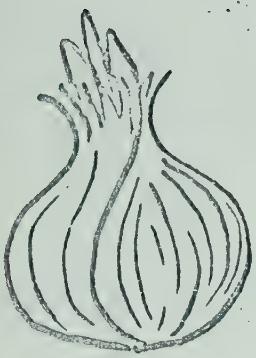

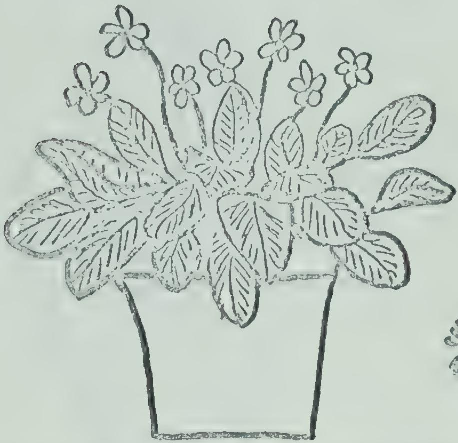

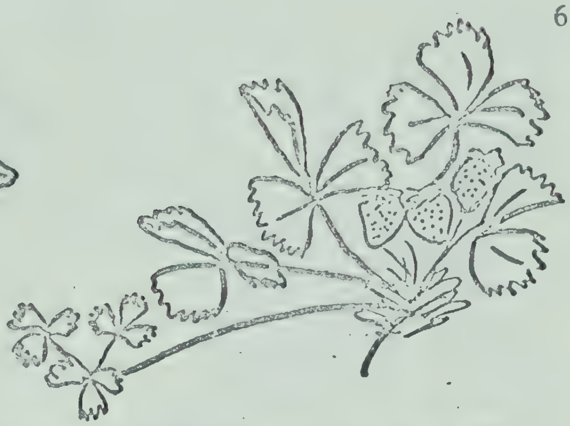

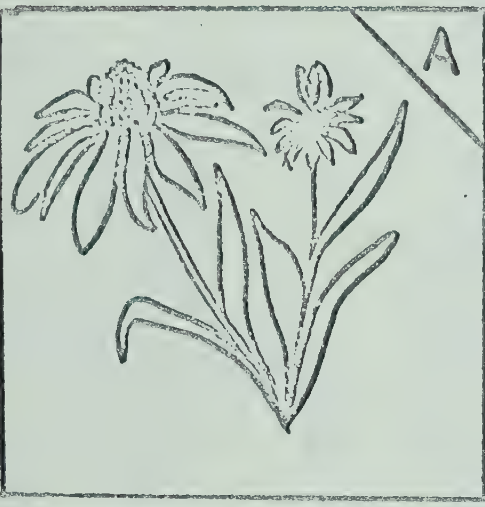

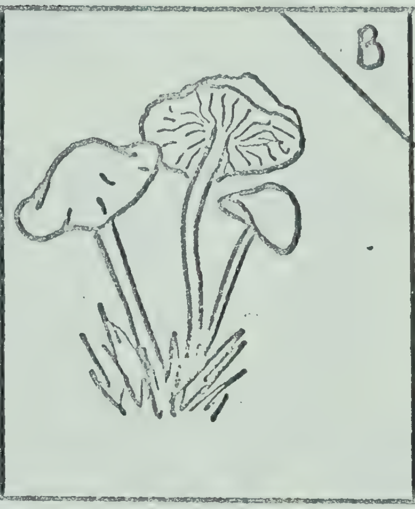

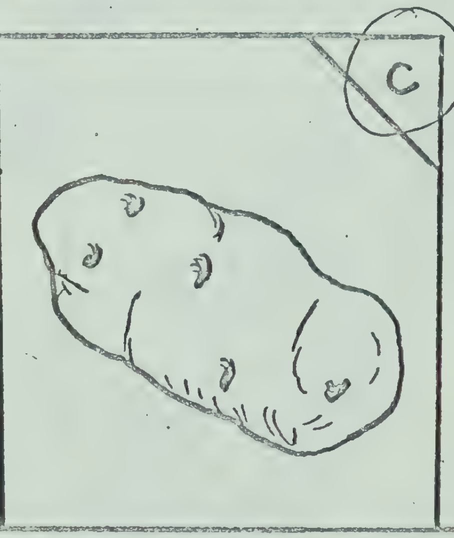

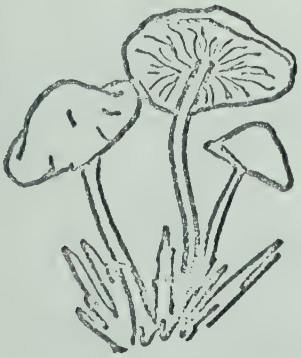

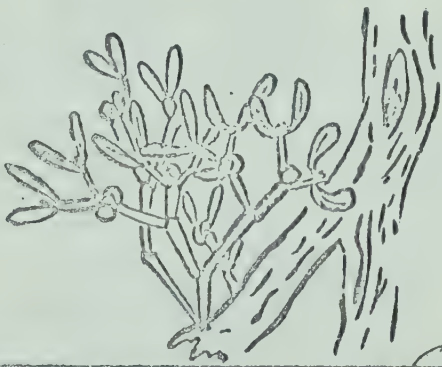

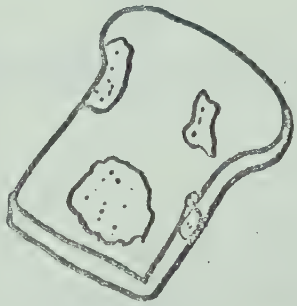

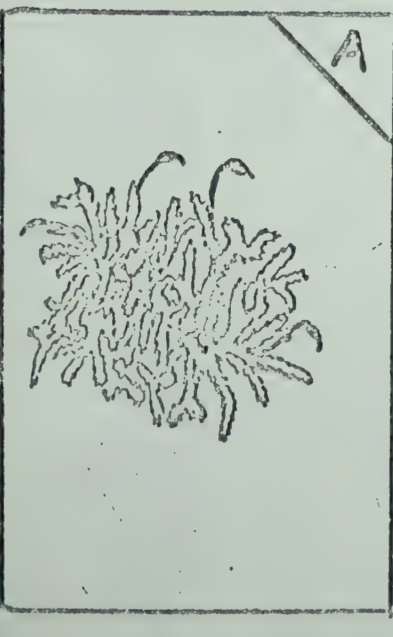

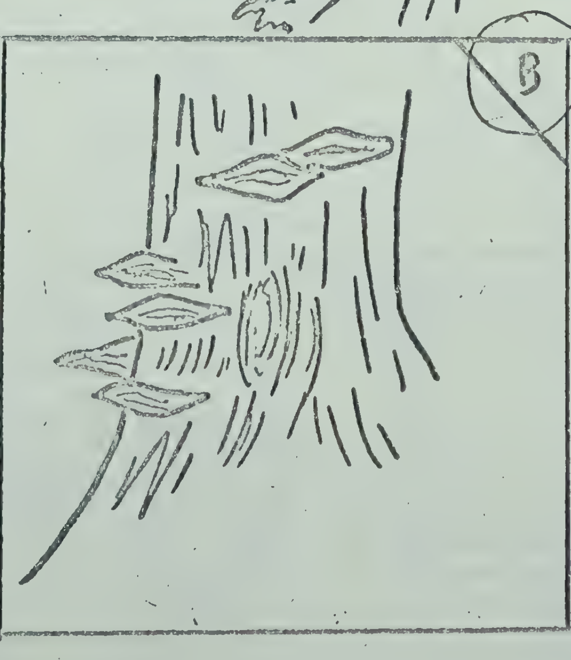

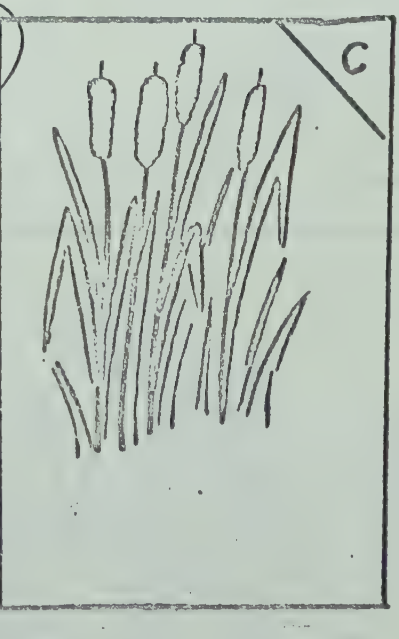

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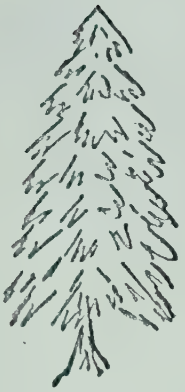

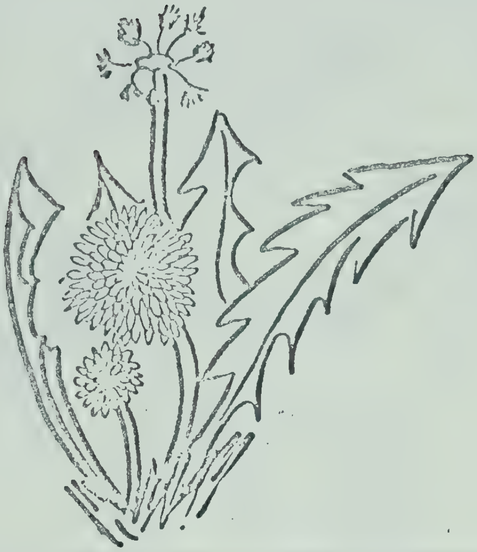

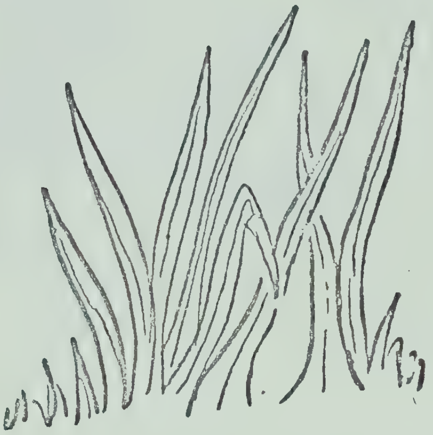

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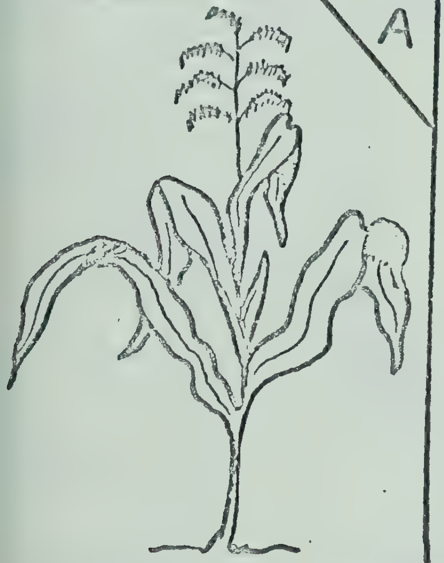

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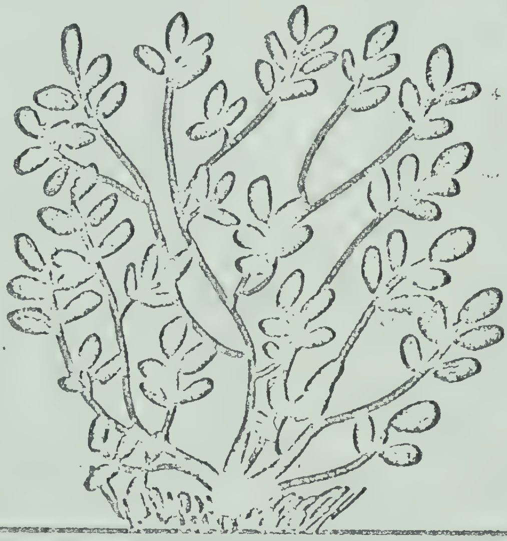

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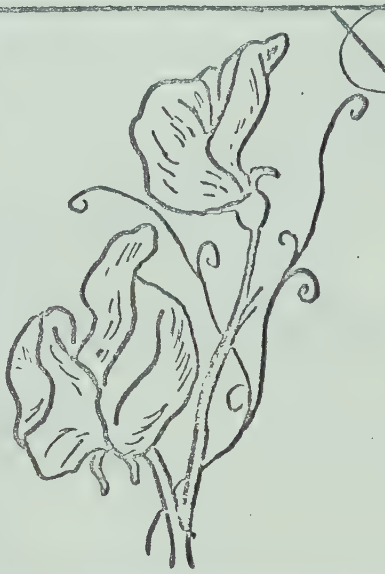

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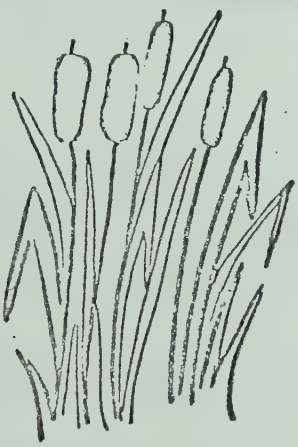

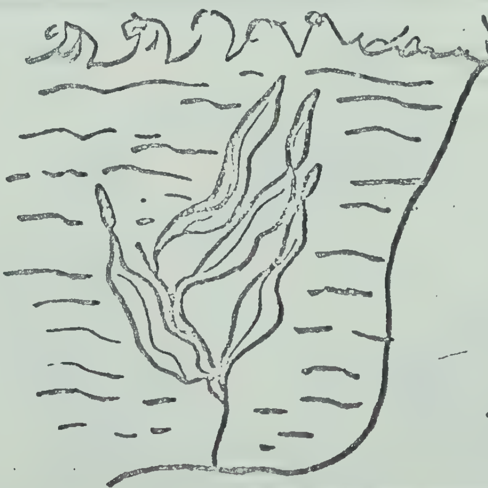

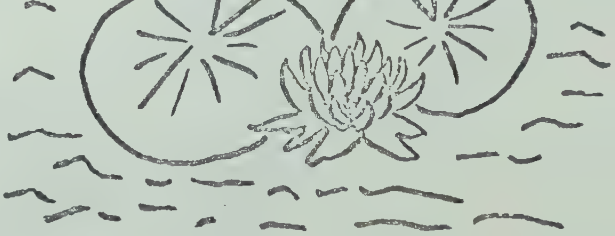

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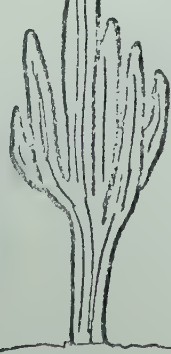

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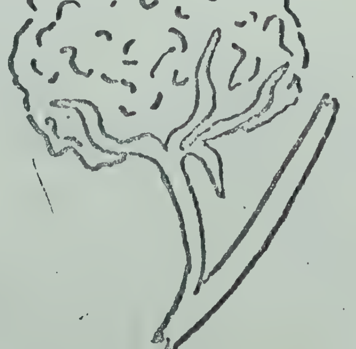

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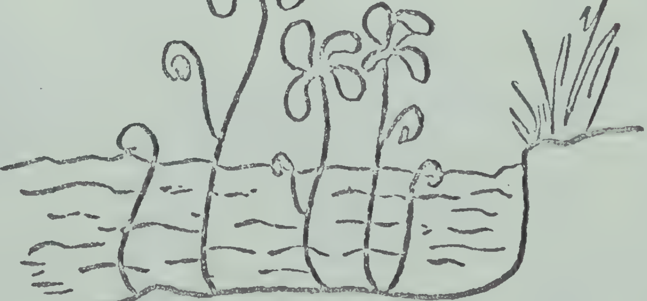

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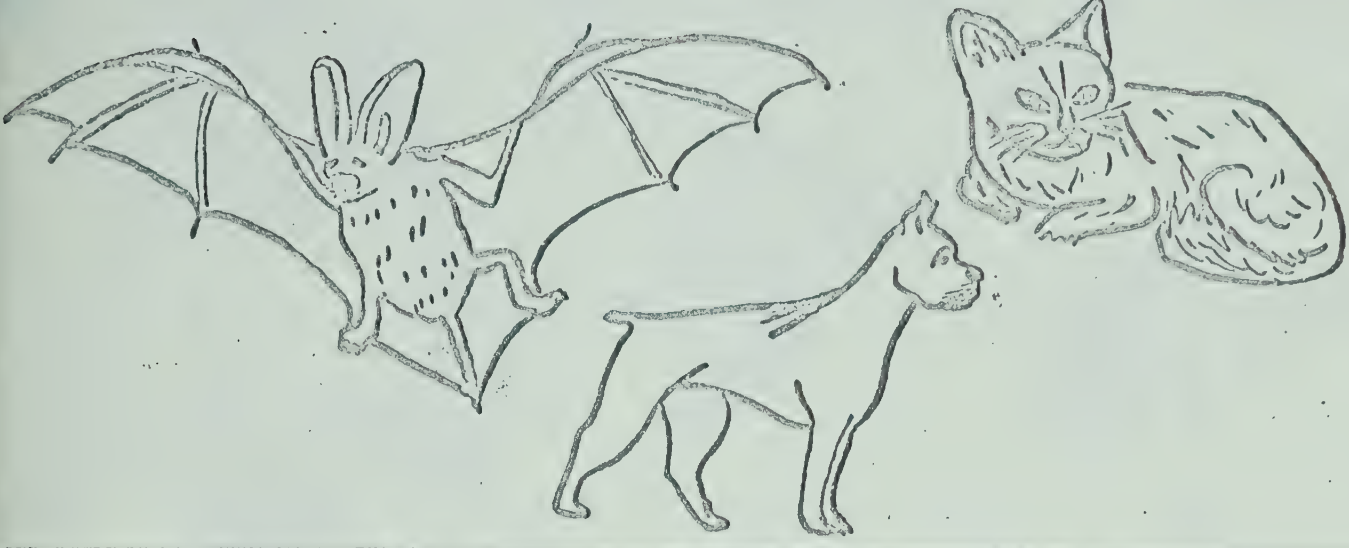

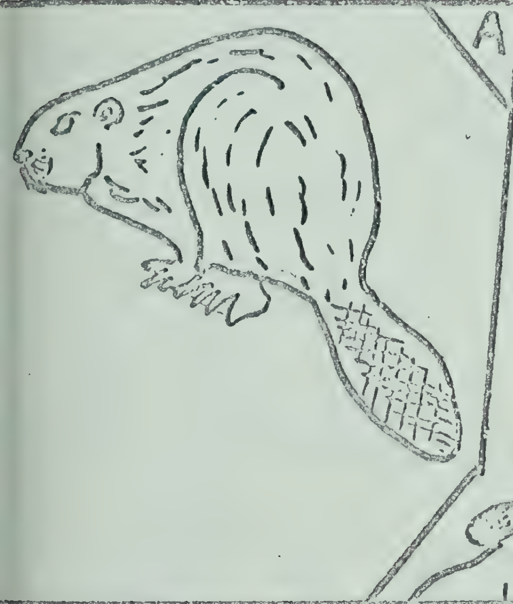

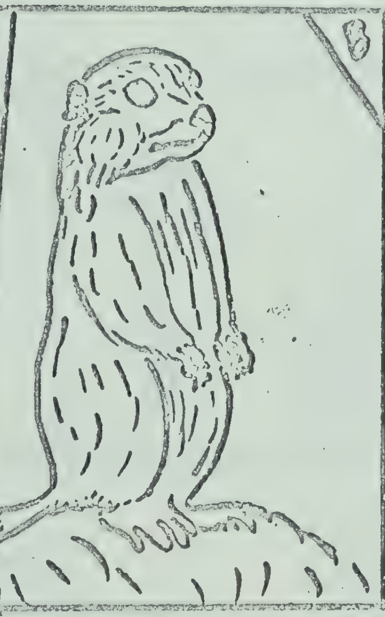

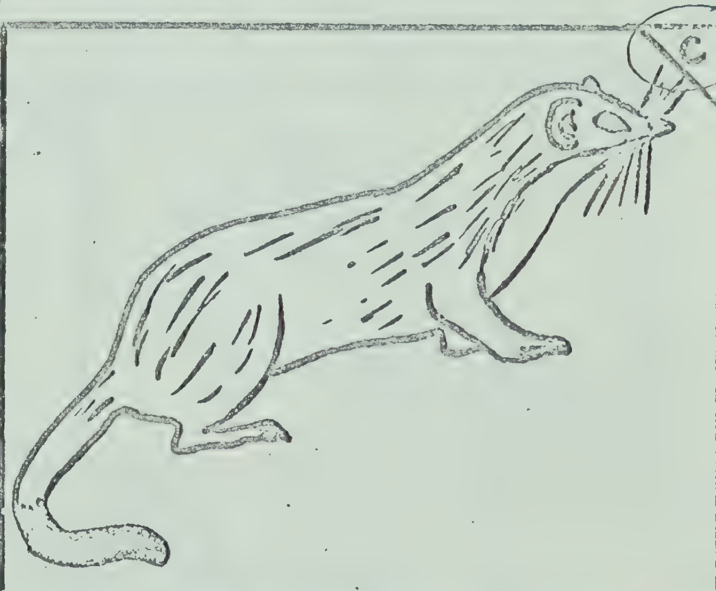

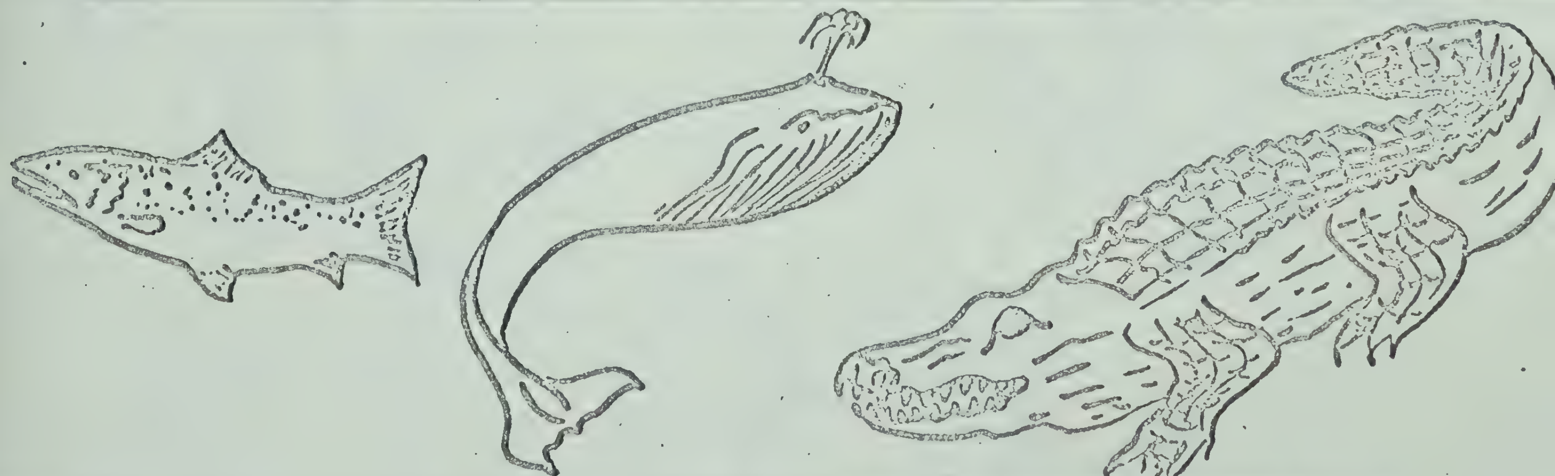

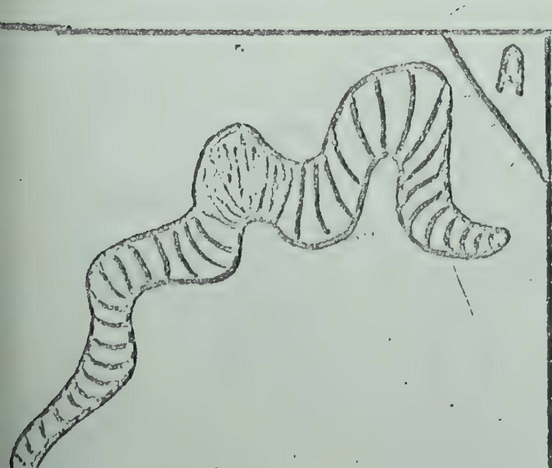

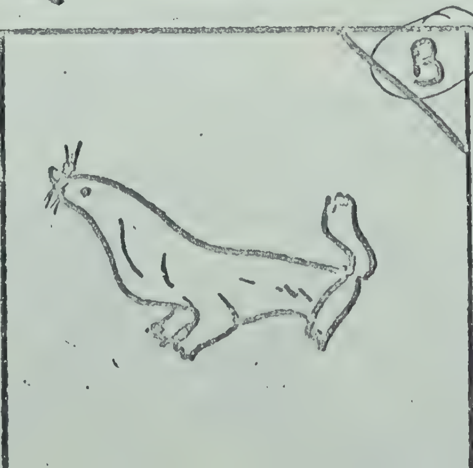

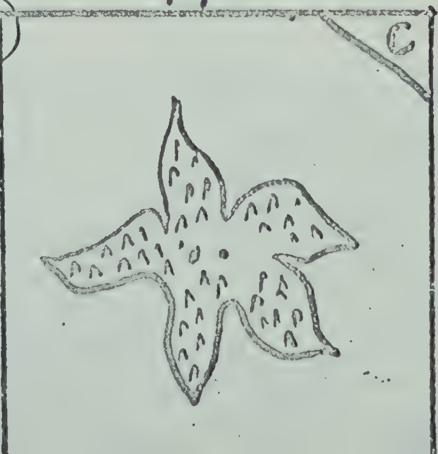

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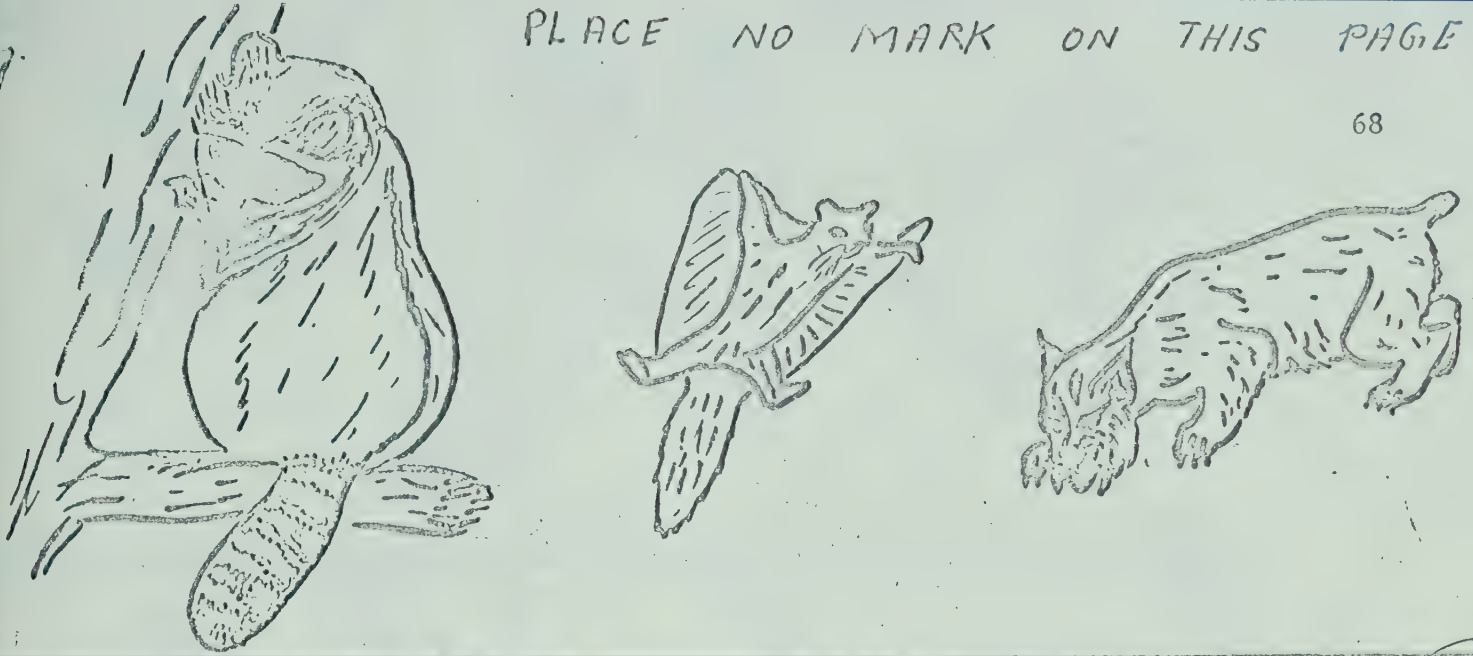

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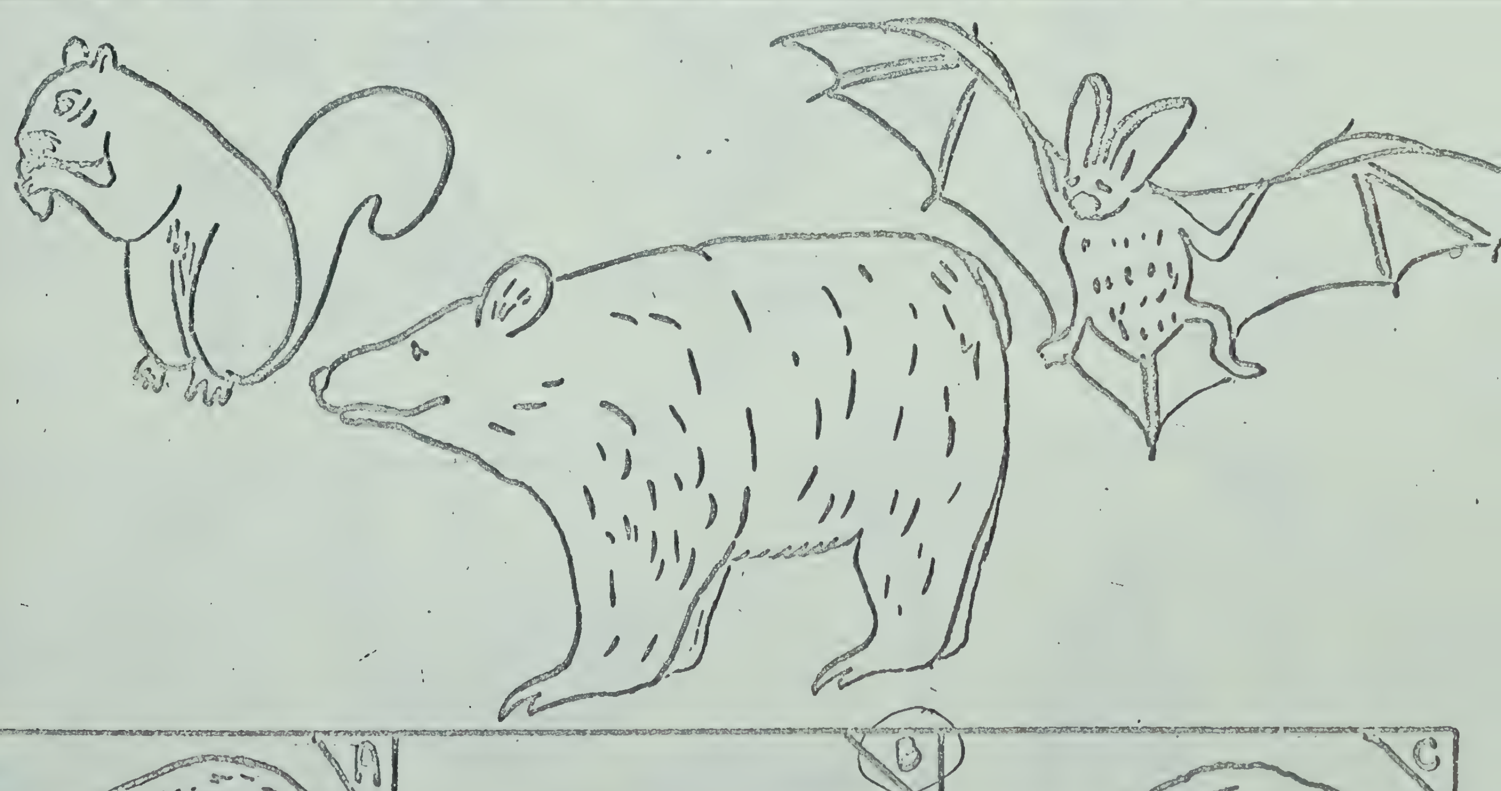

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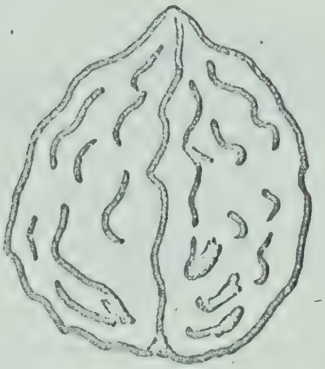

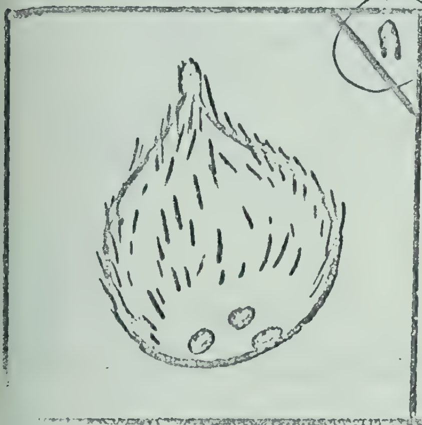

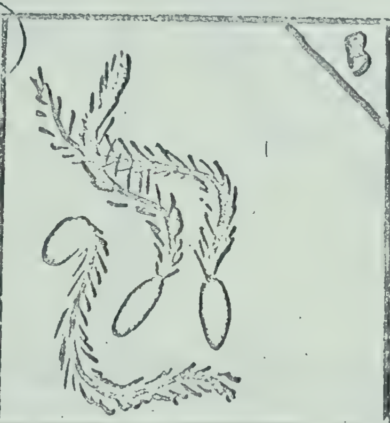

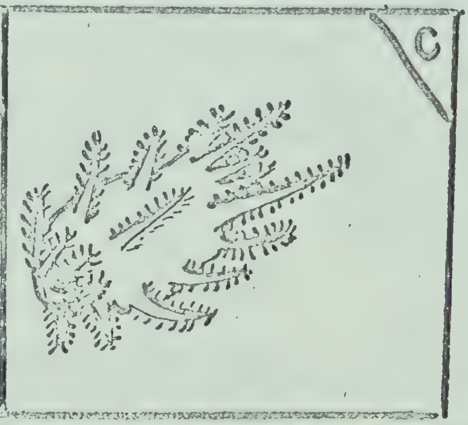

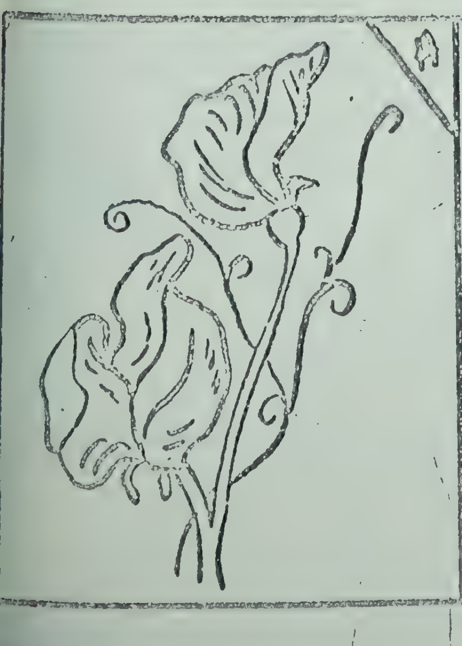

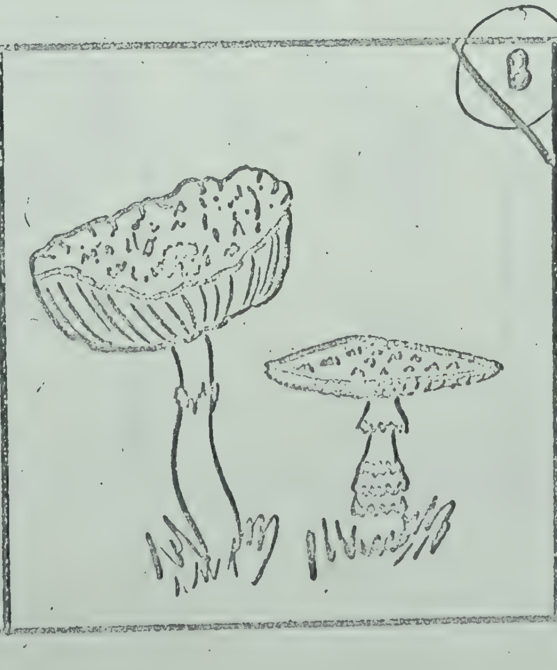

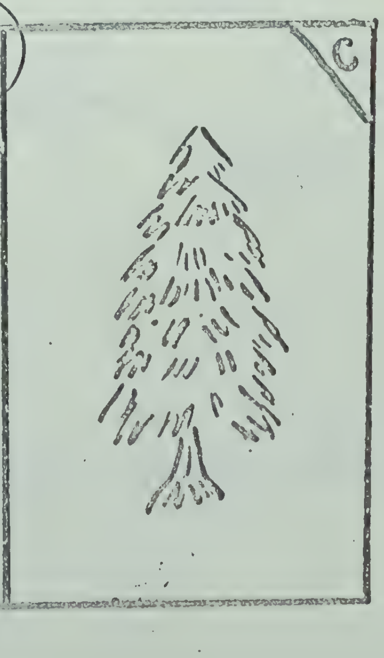

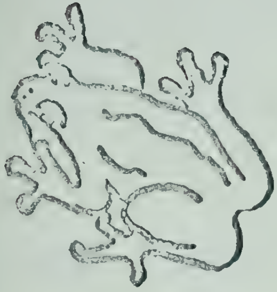
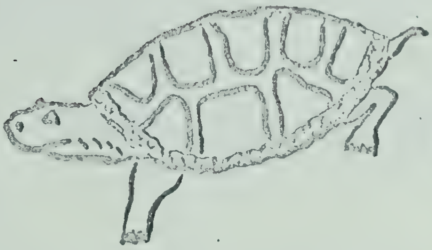
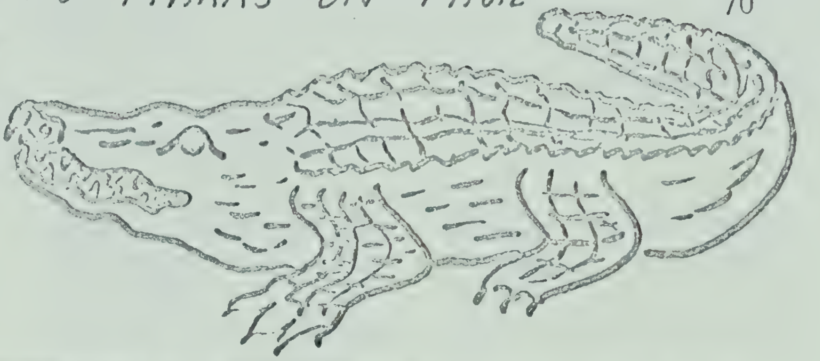

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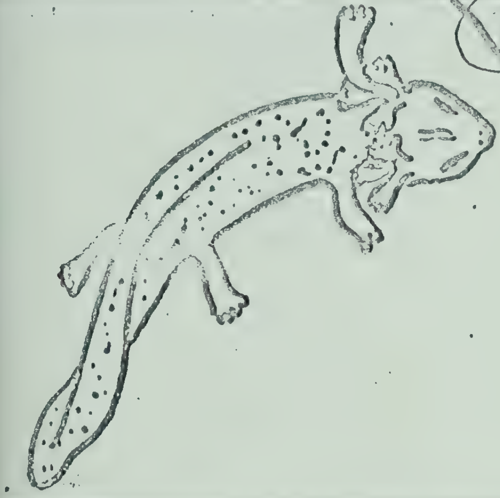

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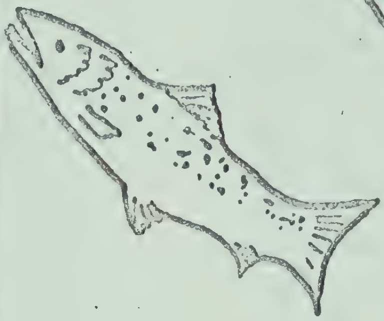

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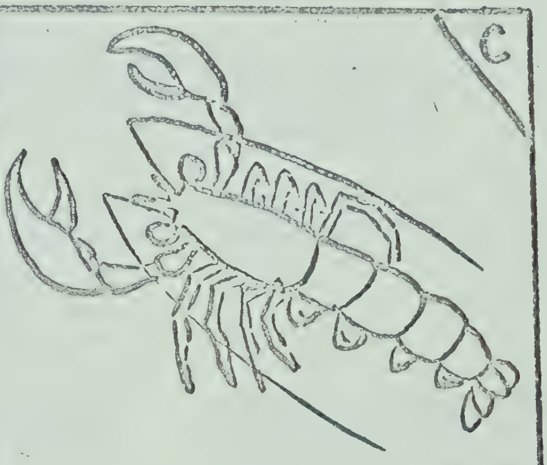

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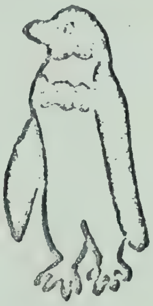
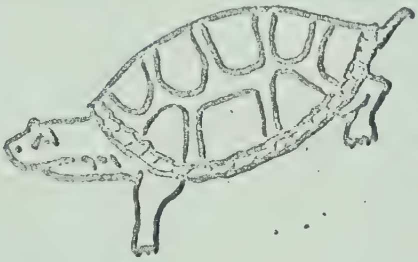
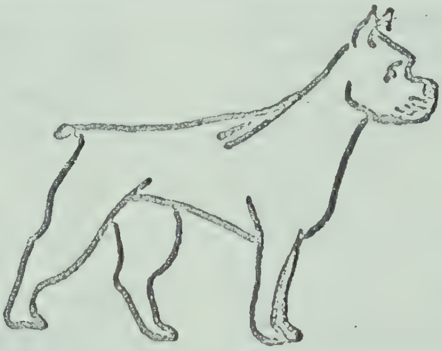

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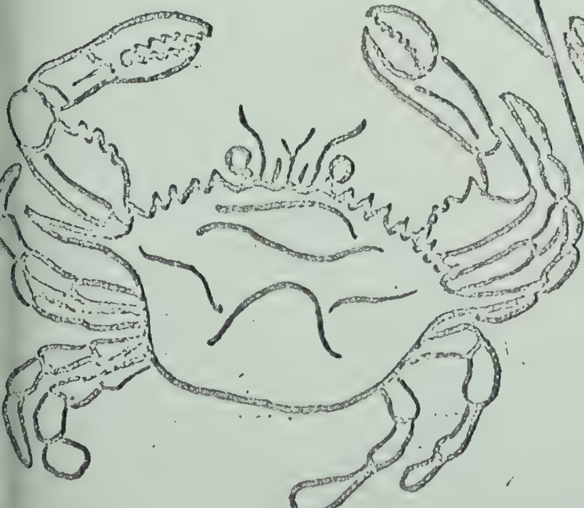

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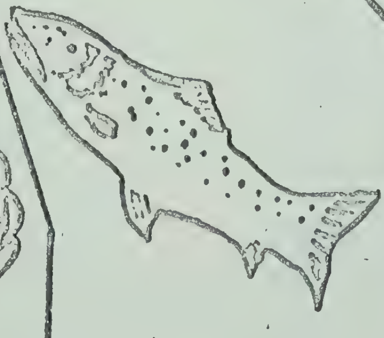

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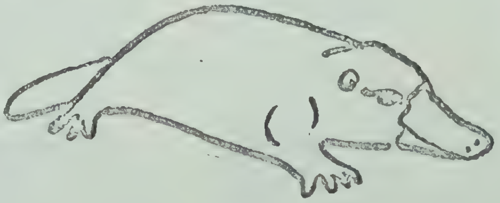


SUMMARY OF RESPONSES TO INTERVIEW FORM

Section	Item No.	No. failing item	Typical Responses of those Passing	Typical Responses of those Failing
I	1	2	Wheels and car go that way	Tires go that way
	2	1	Water makes it go, pushes it, that way	Lift water and throw it up No reason
	3	1	30 is more pull or force on spring: 30 heavier so pull down more	Could be ozs. or lbs.
	4	3	Hot air causes drops to form	Cool air to clouds to make rain: Cold water makes hot water steam
	5	1	Moist air will drop water and then be dry Moist air loses water	Cold to get mist - shower going on - warm air causes evaporation to make clouds. Cool air to clouds to make rain
	6	4	Arrows of belt right way to make propeller go around	Belts go that way: On windmills
	7	2	Salt can get through filter but sand can't Salt and water through	Only water is liquid Sand goes through with water
	8	3	More pressure at bottom	Higher one slants less Top has farther to go to get to ground All go out same All go slowly unless something pushes
	9	2	When air goes ← balloon goes → Air goes out and it goes that way	Air goes up Air going into balloons so go that way

Section	Item No.	No. failing item	Typical Responses of those Passing	Typical Responses of those Failing
I	10	1	Closer to heat melt first Wax nearest will get warm Heat goes along rod from candle	None
	11	3	Salt makes things float Salt water holds stuff up	None
	12	4	Frayed ends No difference	Coating off others Wires not frayed or crossed let electricity go
	13	5	Wider pitch makes it go down faster Wider coils go faster	Thinner pitch makes it go down faster Can't see difference
	14	1	With complete circuit nails pick up tacks A switch Electricity will work if switch is down Will be a magnet and attract tacks	
	15	4	Magnet will attract it through glass	Steel conducts so will attract ring Magnet can't pull through glass Iron carries magnetism
	16	3	Light can go from mirror to mirror Reflections go that way to see bird Angle mirrors to let light go out	Bird sees itself, goes down and eye sees it

Section	Item No.	No. failing item	Typical Responses of those Passing	Typical Responses of those Failing
I	17	4	2 new magnets 2 cut ends will form new N & S old ends don't change	N & S stick together before cut and go together after Still the same if just cut in half Belong on same side
	18	5	2 pulleys make it easier. More pulleys you have the less it weighs. Less effort	Pulleys show weight and go down Pulleys and force act together Both weigh same
	19	5	Coil & batteries & put on - it will work Complete circuit	
	20	1	more magnetism on bottom of poles Tacks stick mainly at end Only come to poles	Tacks shouldn't stay in one place
	21	4	Sun rises in East Other way is backward only this way causes night and day	Sun's rays and heat go that way
	22	4	less direct on bottom box More direct on top so hotter	Angle on top one so not as warm Light hits both at same slant
	23	5	Hammer will pull out best Fulcrum more efficient	Better curve to get it out easier Pulls nails out best
	24	8		Darker it gets at noon, sun directly over Standing right under Sun right over at noon shows more shadow

Section	Item No.	No. failing item	Typical Responses of those Passing	Typical Responses of those Failing
I	25	8		Nail because it will carry current Nail completes circuit Glass will not conduct and light is not on Paper and glass do not conduct
II	1	3	Nail attracted to magnet Nail picked up only	Water is non-conductor Magnet can't attract
	2	5	Magnetism will go into hammer Magnetism will leave	Magnet attracts head of hammer No effect
	3	5	Just water will evaporate Others will not evaporate	Salt water comes out Food color comes with steam
	4	5	Crack only Breaks Coke bottle - so breaks rock	No effect Burnt rocks don't break
	5	6	Cut off bud nothing will grow Only one dies; uncut one will grow	Will grow back If one is cut others on same branch won't grow
	6	5	Water can't come in because of air still there	Water will get in Glass will fill with water and cork float in it
	7	1	Wire heated, weight Wire gets soft and goes down Wire expands	No effect
	8		Steam has to get out Hot water has to go somewhere Water expands	

Section	Item No.	No. failing item	Typical Responses of those Passing	Typical Responses of those Failing
II	9	1	Others will grow faster & it will stay small Only cut one dies	All grow
	10	2	50 & 100 will balance there Move 100 up to balance	100 more than 50 so goes down
	11	2	Plant has to go up toward sun Needs sunlight Roots go down	Nothing will happen
	12		Cold and hot around it make it pop Heat bursts it Air expands inside it	
	13	2	Salt mixes, sand sinks, oil floats	Sand will float, others will sink
	14	2	Water rises when solid piece put in	More pressure on water Water will splash out and be less
	15	1	Will evaporate 1/4" will evaporate All evaporate	Stay the same
III	1	6	All mammals All wild animals	Need warm temperature All in N. Hemisphere
	2	10		All live in water Connected with water Live in sea
	3	8	All eat plants	All hibernate? Wild animals Small animals All have fur Live in forest

Section	Item No.	No. failing item	Typical Responses of those Passing	Typical Responses of those Failing
III	4	1	All reptiles	All long Not common Can go on land Look alike
	5	1	All birds Have wings and use them a lot All have large feet	All have wings
	6	6	All live in ocean bottom	All move slowly Doesn't move
	7	6	All lay eggs	Go on water slowly and make homes there All walk
	8	6	All fly	All fly or glide All soar in air All have wings
	9	2	Form leaves Out of ground All not roots All vegetables	
	10	5	Some parts alike All on trees All fly from plants	All seeds but can't say anything about them Sort of wings
	11	9		Form flowers All plants Plants to look at All leaves
	12	5	Hurt people All grow on other plants Can eat all of them Mold or fungus	
	13	8	People grow them in yards	Don't move much All form bushy plants Grow in woods Trees Funny leaves Prickly ends

Section	Item No.	No. failing item	Typical Responses of those Passing	Typical Responses of those Failing
III	14		All water plants	
	15	4	Go fast All eat other animals All have tails Run Don't live in water	All dig Mostly on land
	16	3	All swim Go in water All grow in water	All live in water
	17	2	Dangerous Outdoor animals All climb trees Not pets	Get vicious
	18	6	All carry diseases Lay eggs on land	All hibernate All live in woods
	19	3	Food for animals All grow on trees See more often All nuts	All seeds
	20	8		All tree-like All have sharp needles
	21	6	All have four legs All amphibians and reptiles Go on land and water	All don't live under water Go on water but do not live there Move slowly Scales
	22	4	Can't tame them All go on feet A & B don't fit together All go on land	Have all kinds of animals

(NOTE: Occasionally it will be seen that a student has appeared to have failed an item for the correct reason. However, if one inspects the item involved, it will be observed that the student chose a very close distractor. e.g. Section III #5, the bat also flies but is not a bird. A student could also choose the correct answer, for the wrong reason, by guessing.)

SUMMARY OF REVISIONS TO INTERVIEW FORM

Test section	Items eliminated	Items revised
1	9, 16, 24	12, 13, 18, 22
2	5	2, 6, 9, 11,13, 15
3	2,6,11,12,20	10, 17

APPENDIX B

(Note: Correct answers are
indicated by an asterisk [*])

PICTORIAL SCIENCE TEST

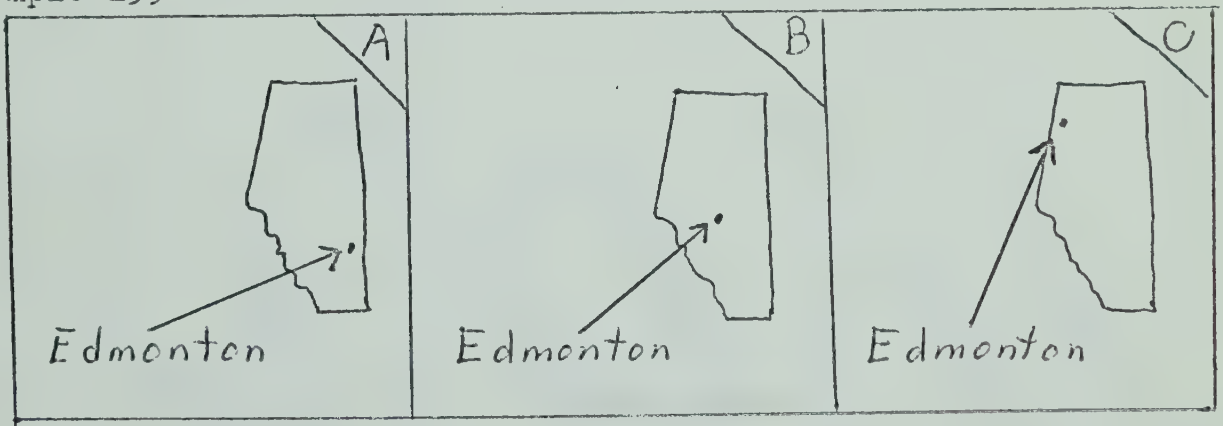
SECTION ONE

Do not write in any way on the pages of this booklet. Place your answers on the separate answer sheet.

In each of the following 25 questions you will be given a problem to solve. It will involve a scientific concept. Only one of the possibilities, A, B, or C is the correct solution. On the answer sheet you will see A 1 B 2 C 3 D 4 E 5 Only spaces A, B, or C should ever be marked. Do not put any marks in spaces D or E. If you wish to change an answer, you must erase it completely. Then clearly mark the answer you prefer. **Start on # 1.**

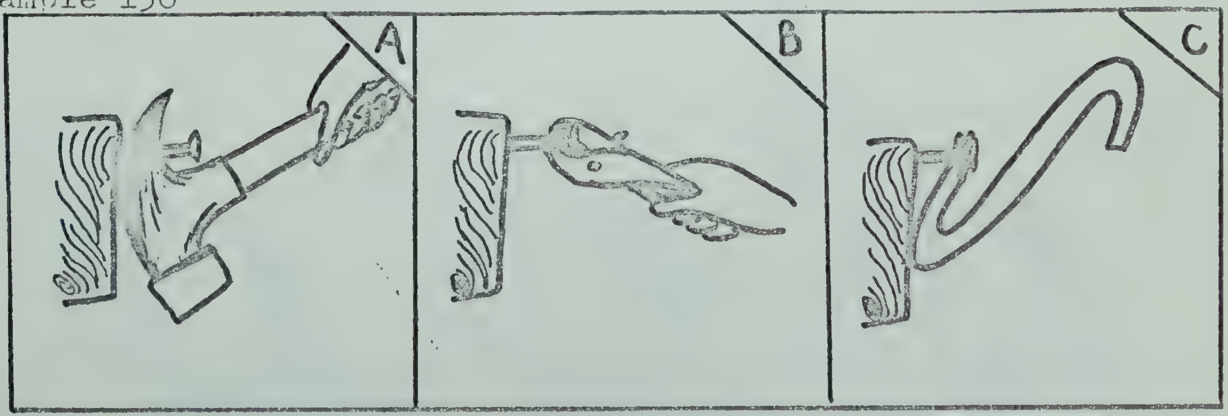
Here are two sample questions;

Example 135



Beside # 135, you should have marked B like this B 2

Example 136



Which answer did you choose?

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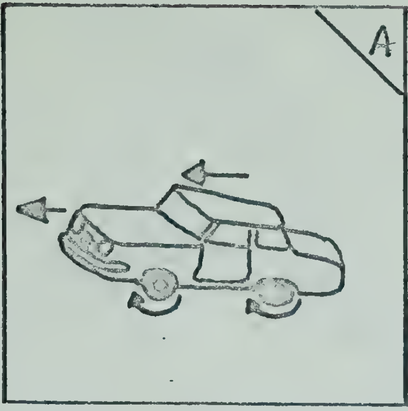

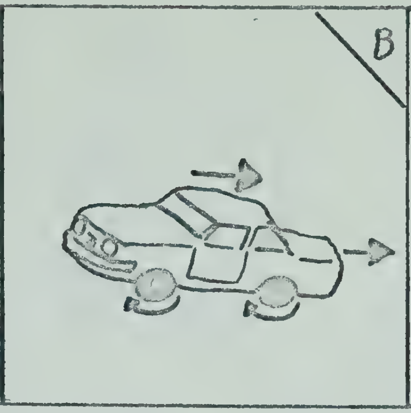

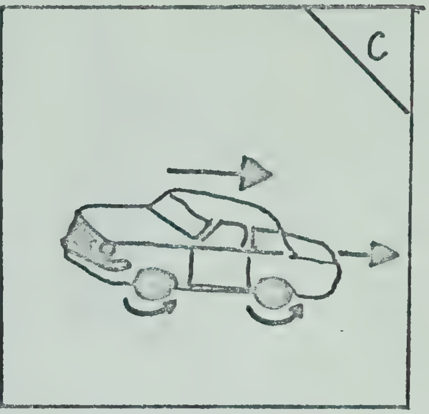

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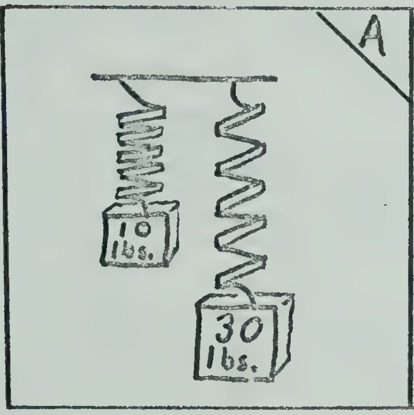
A
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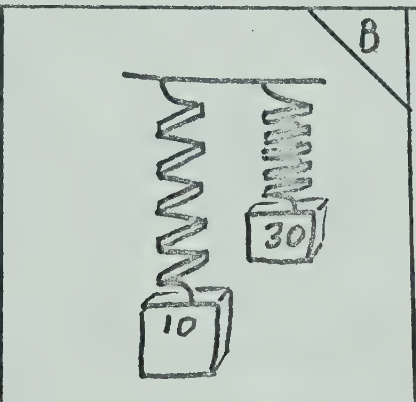

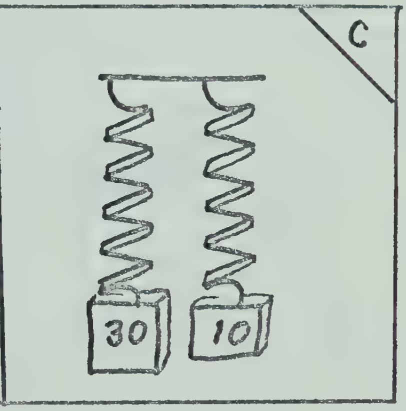

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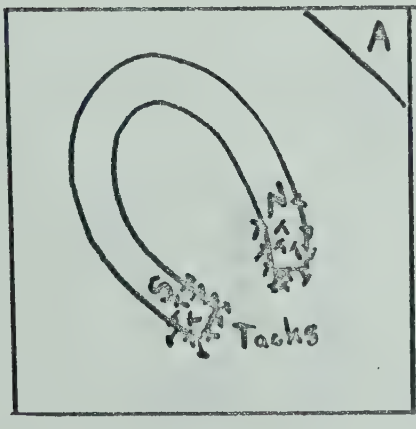

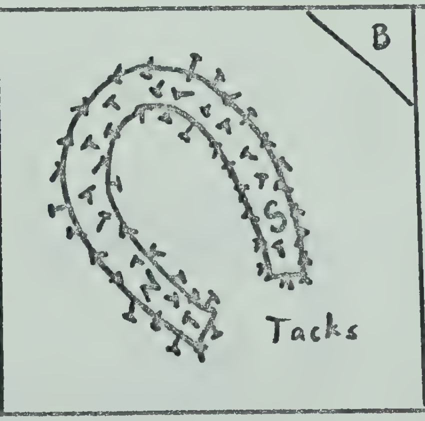

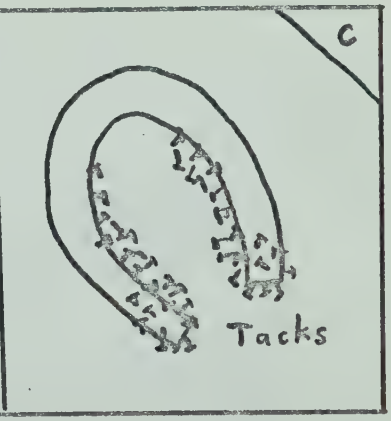

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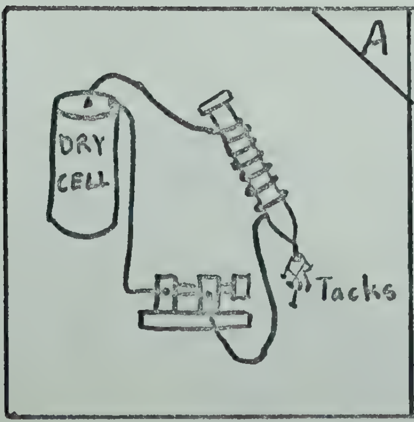

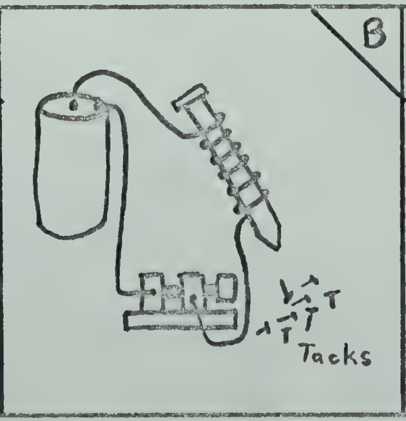

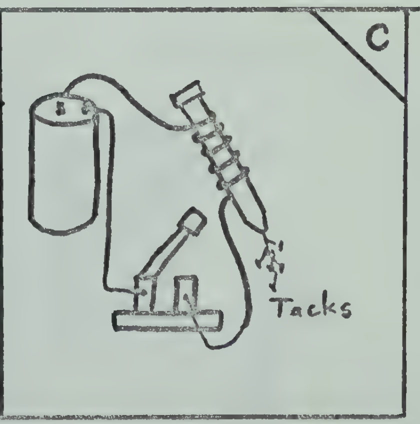

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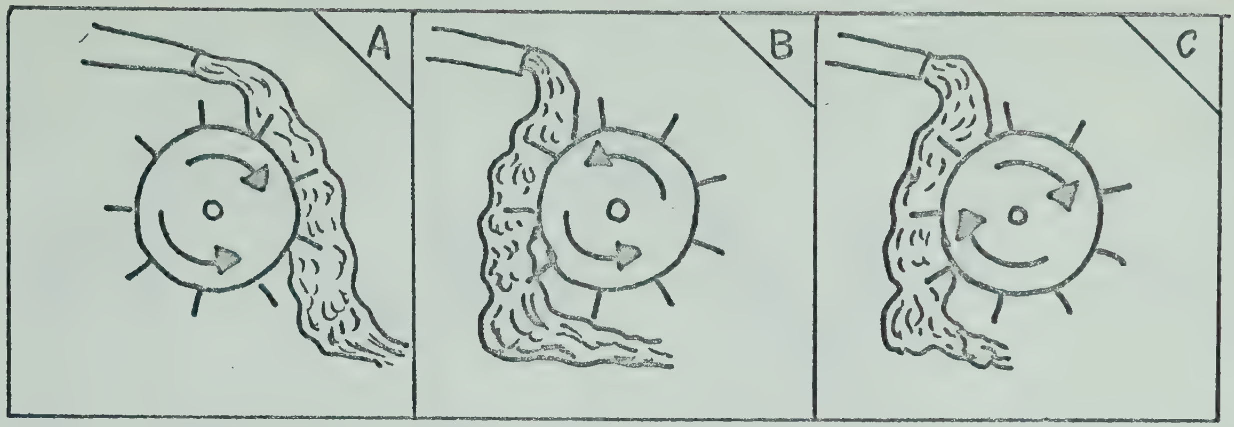

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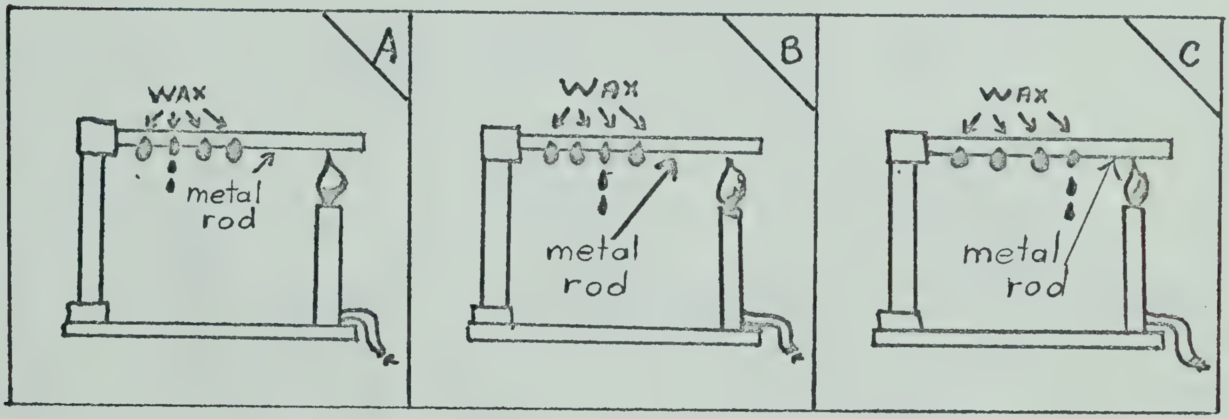

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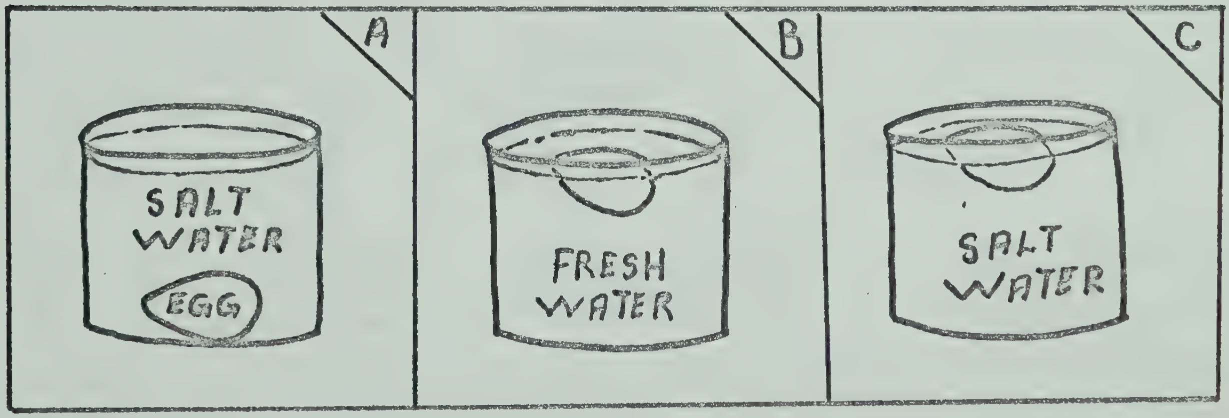

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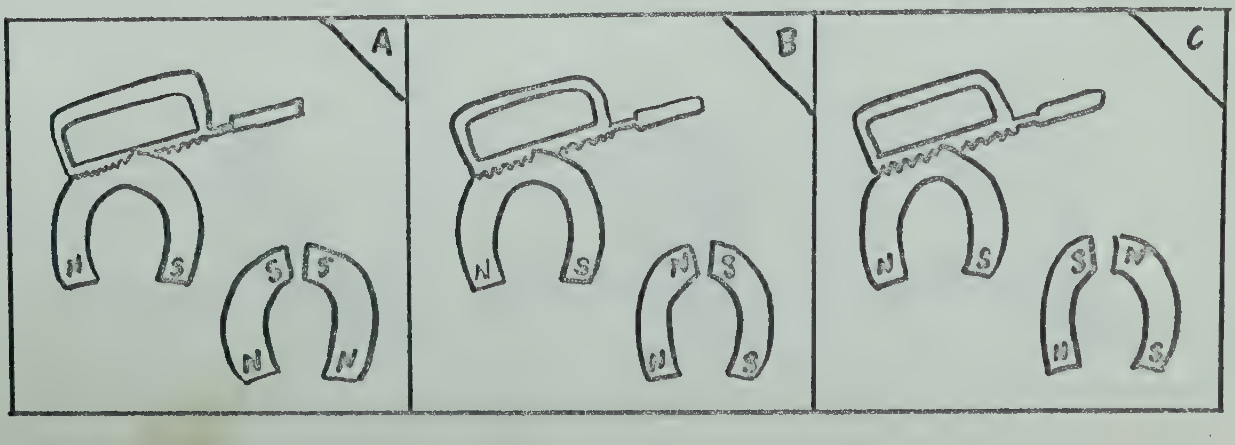

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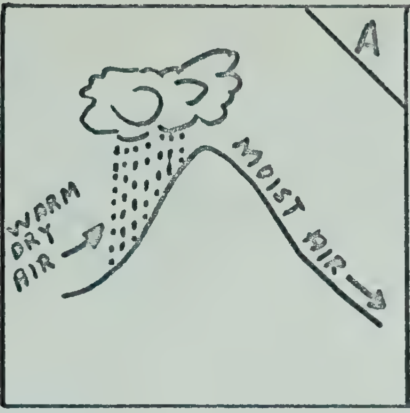

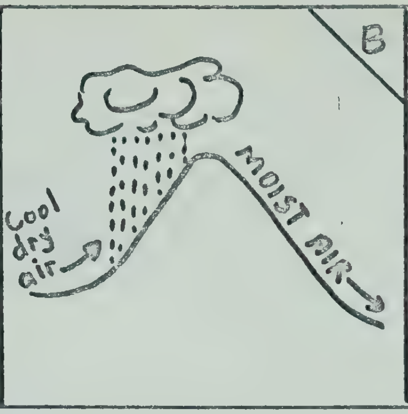

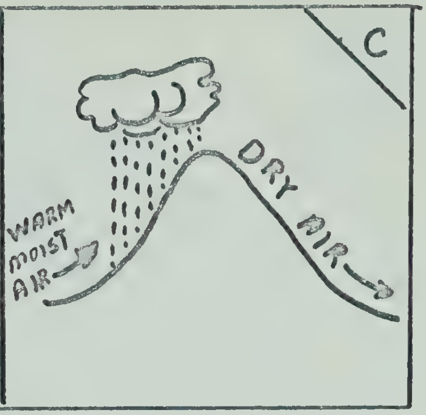

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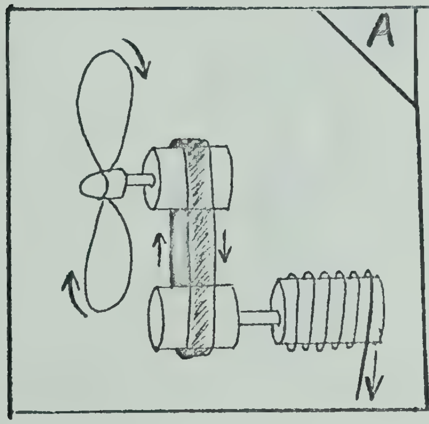

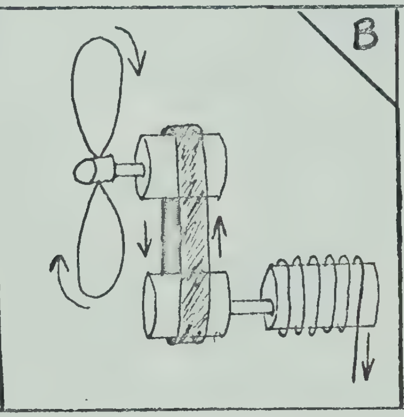

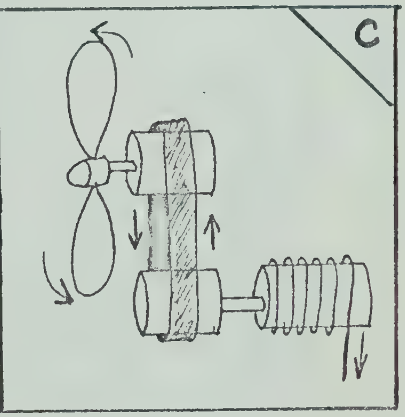

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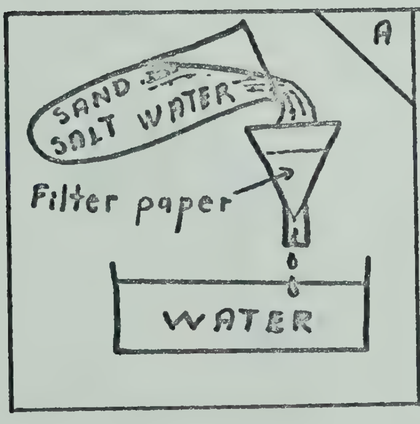

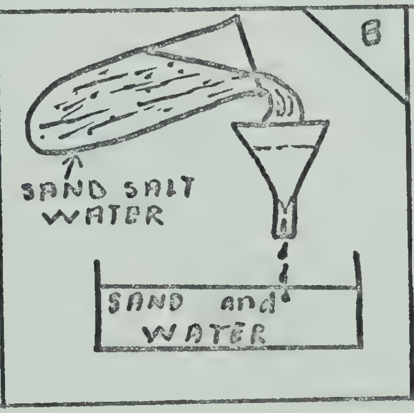

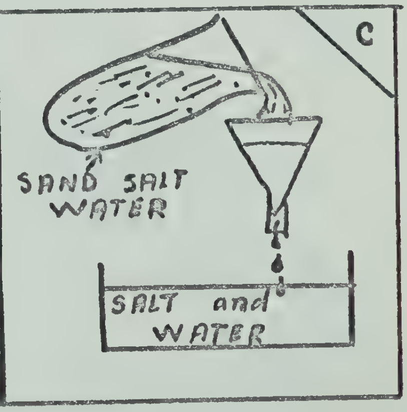

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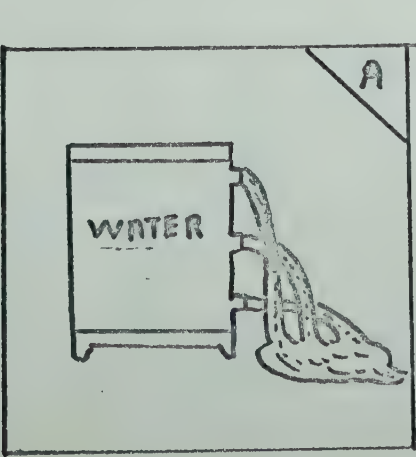

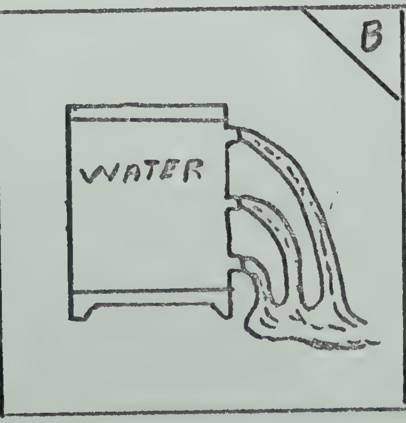

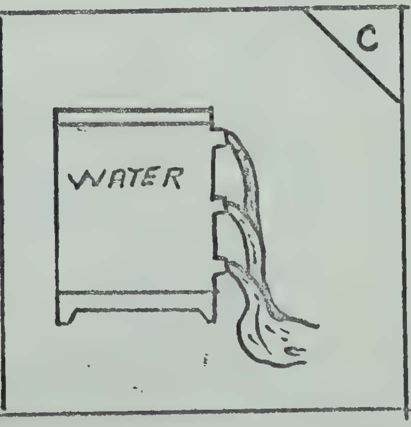

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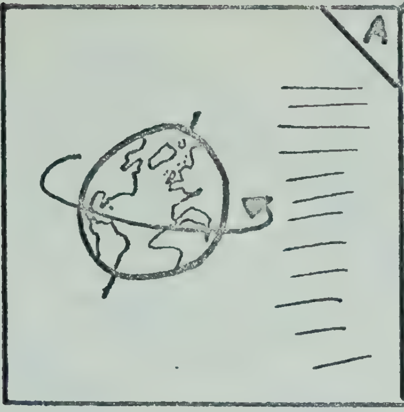

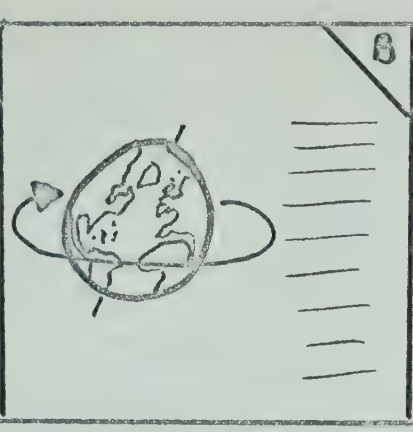

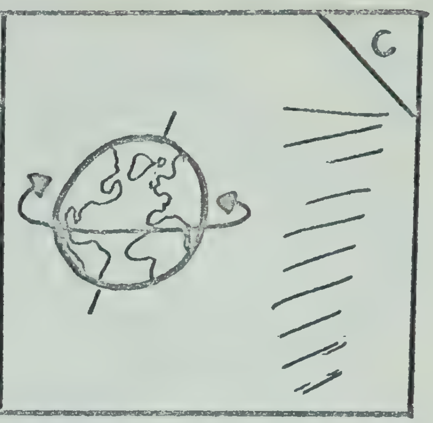

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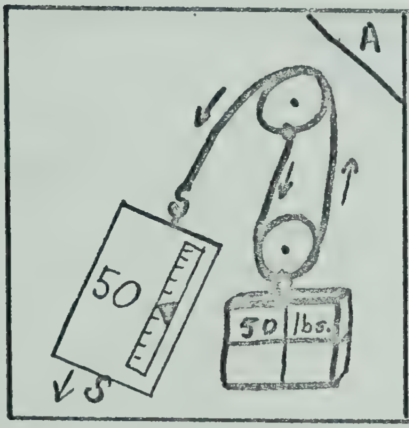

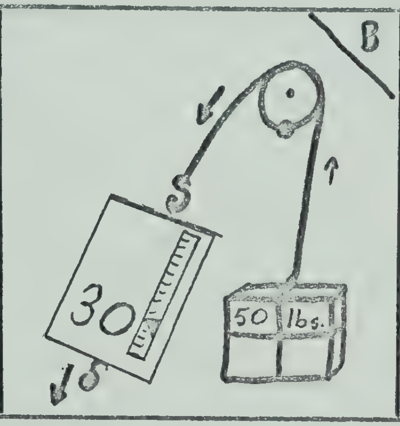

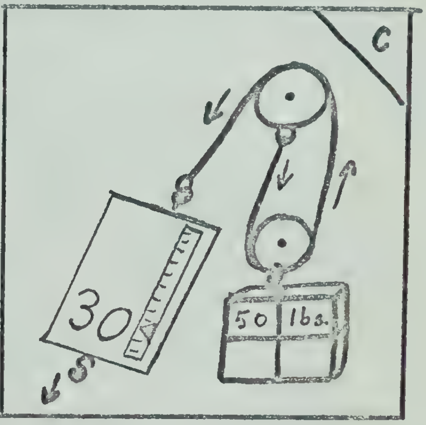

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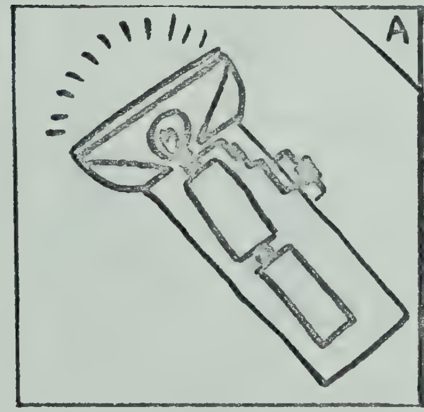

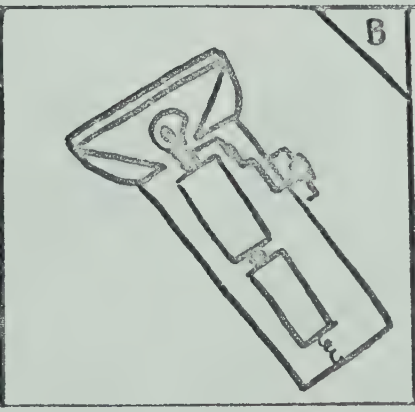

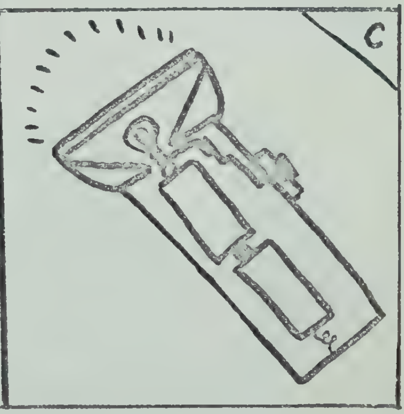

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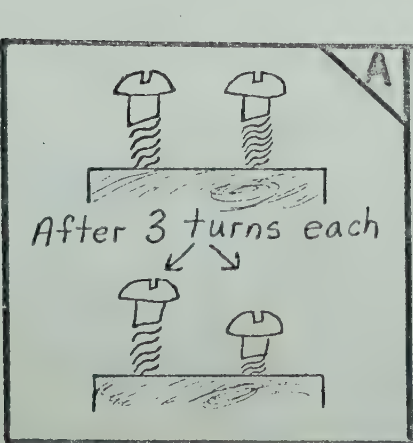

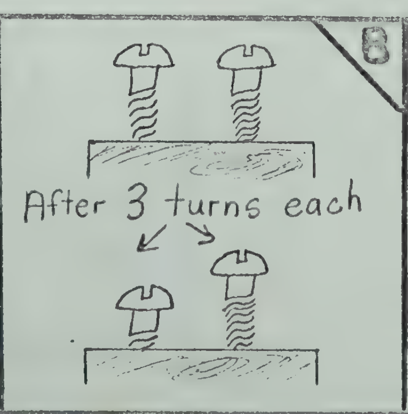

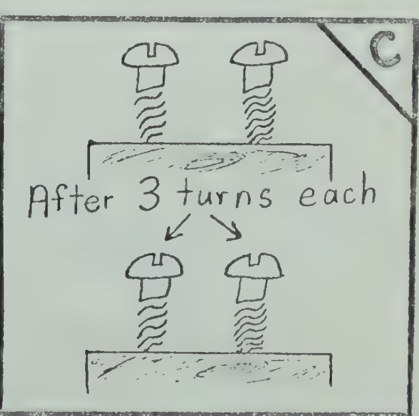

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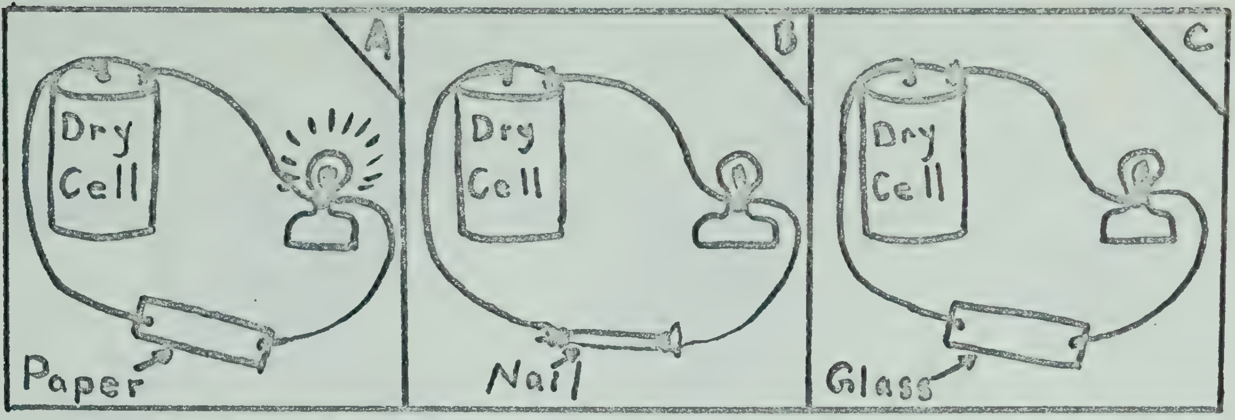

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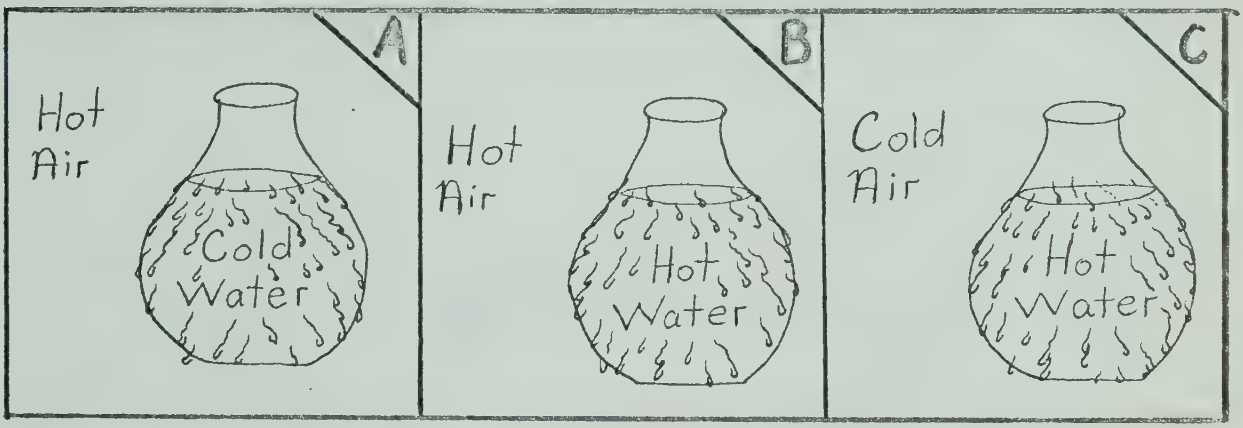

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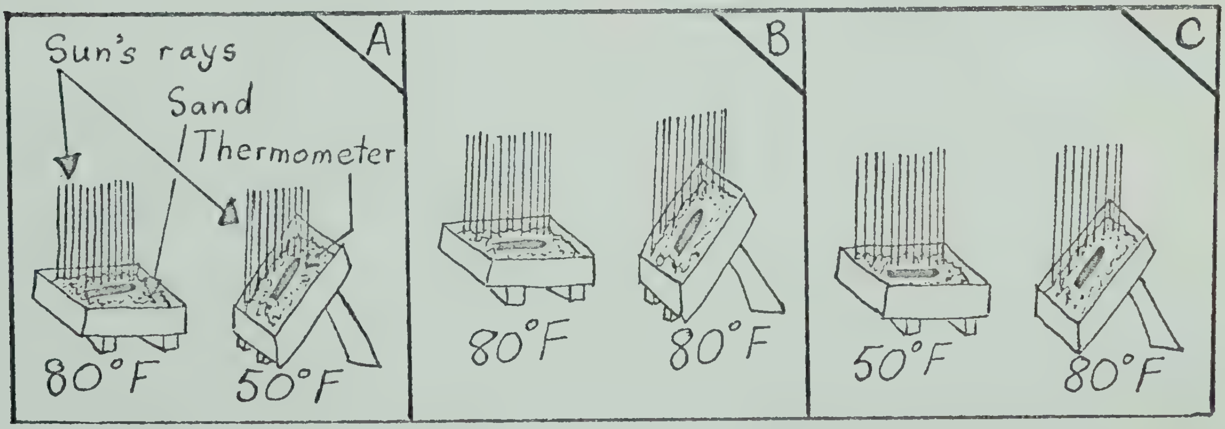

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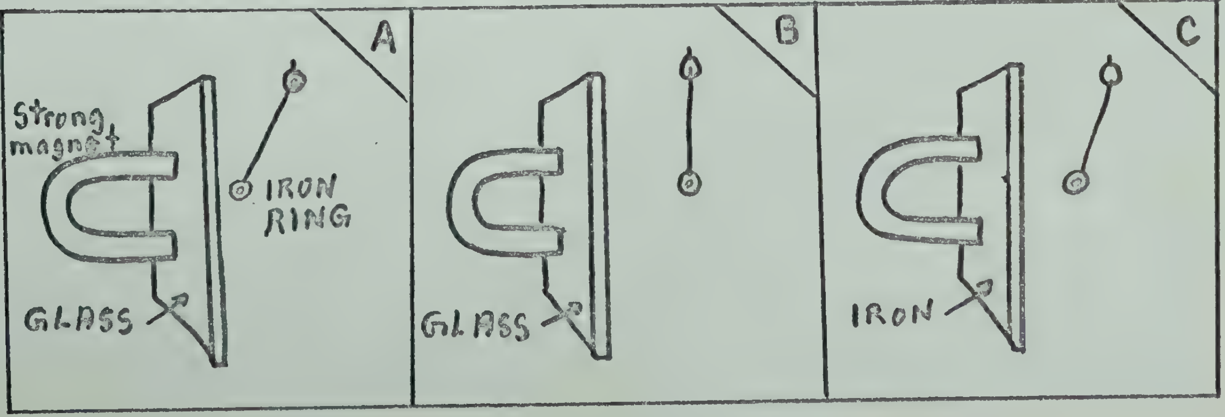

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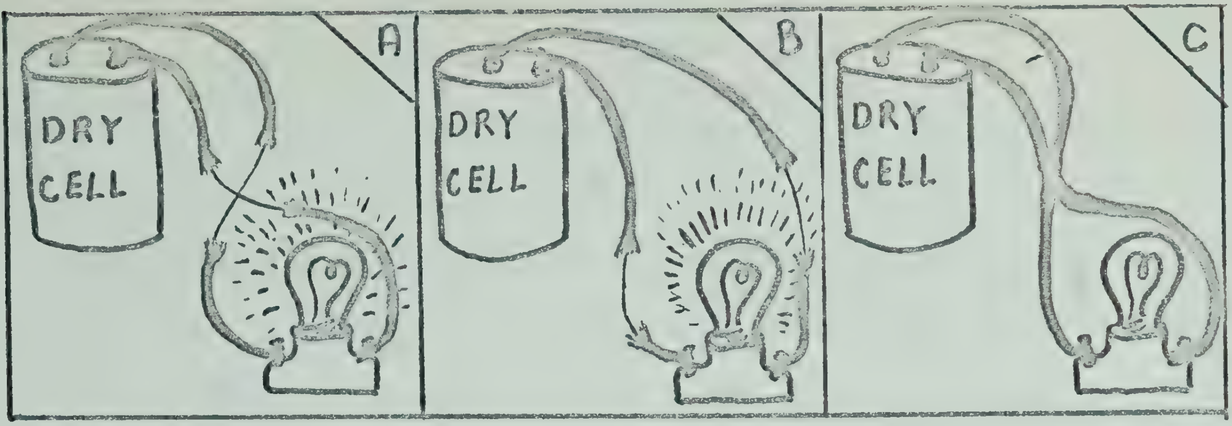

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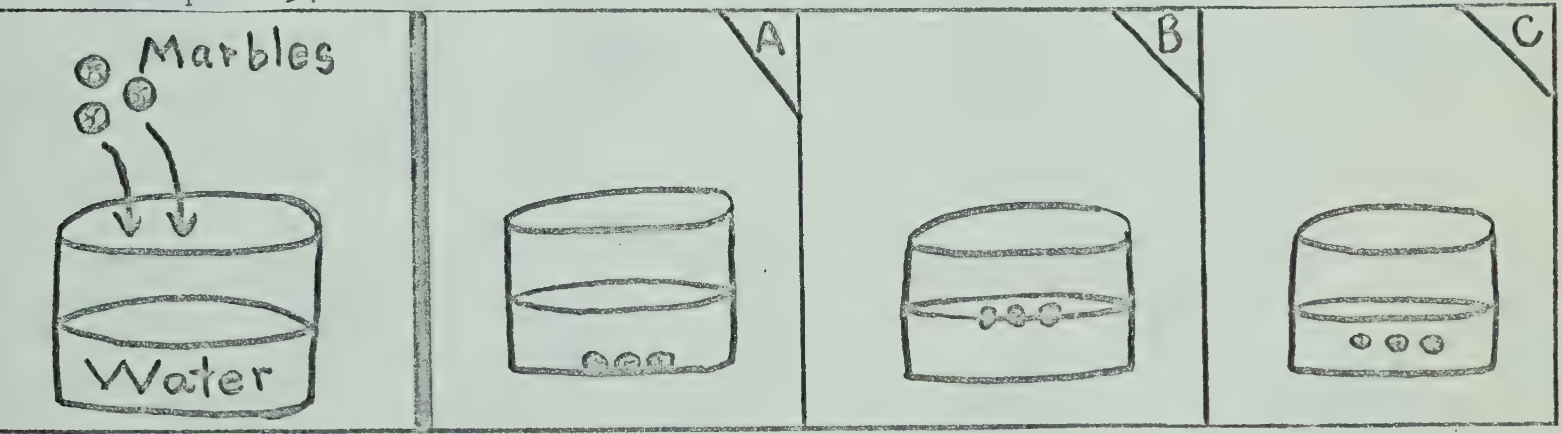
SECTION TWO

Continue through the following 14 questions in the same way you did those in SECTION ONE. Place your answers on the answer sheet, starting with number 22.

In each of the following questions, the first picture will show something happening or about to happen. Pictures A, B, or C will show the possible results.

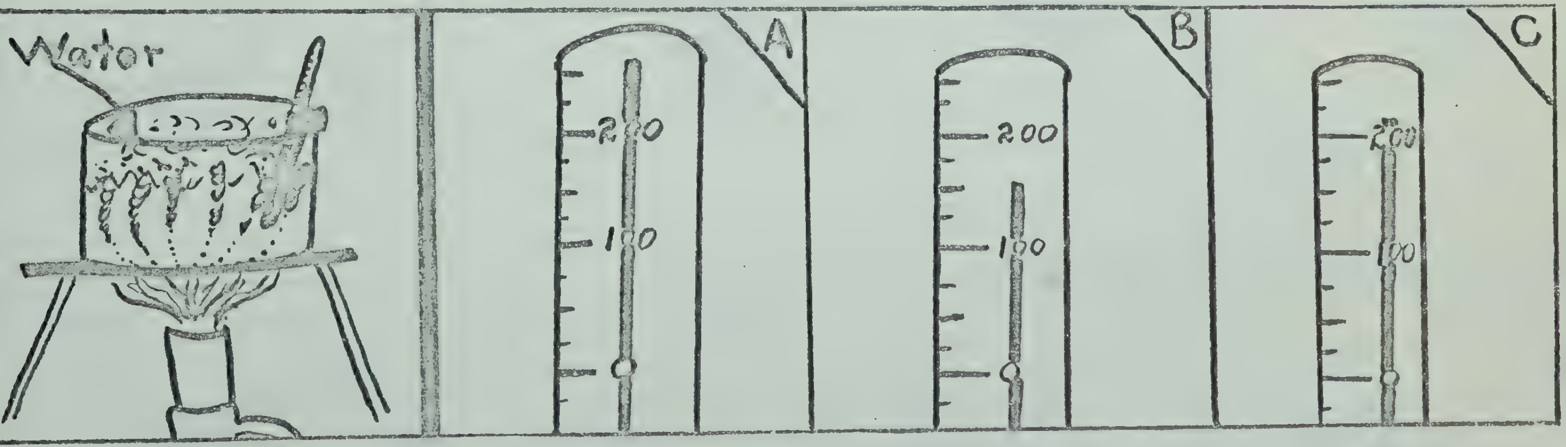
Here are two sample questions,

Example 137



Beside #137 you should have marked A like this A 1

Example 138



Place your answer on the answer sheet. Which answer did you choose?

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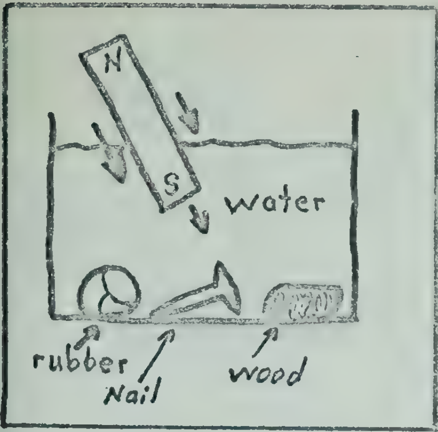

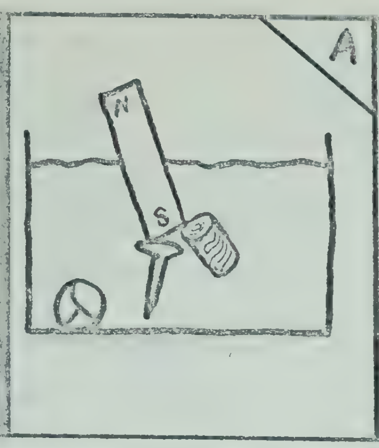

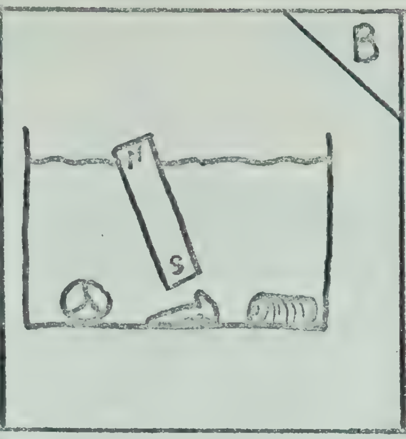

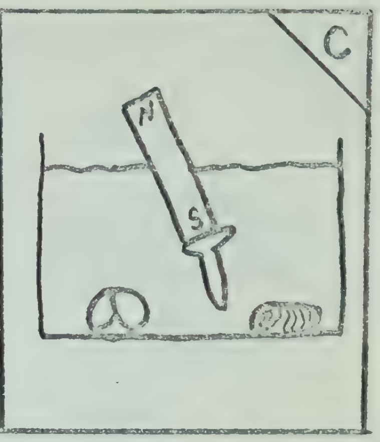

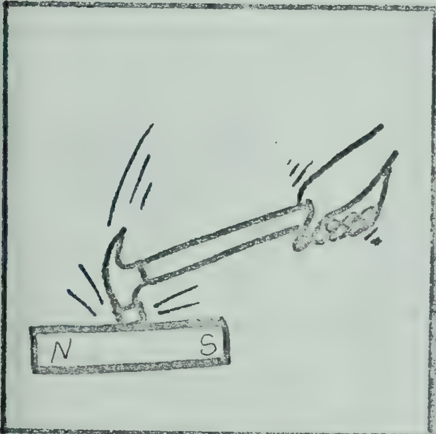

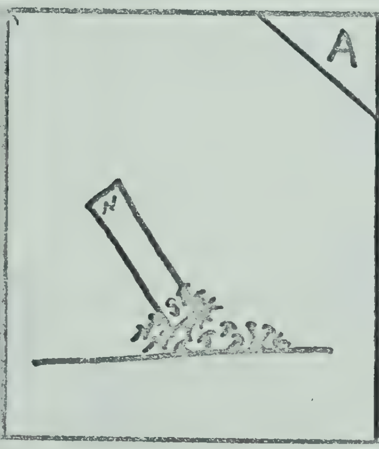

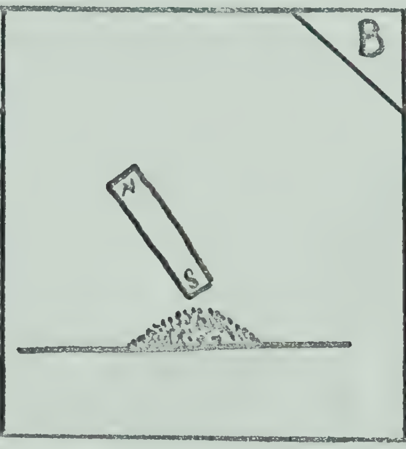

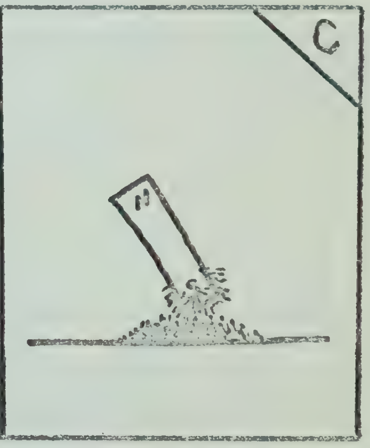

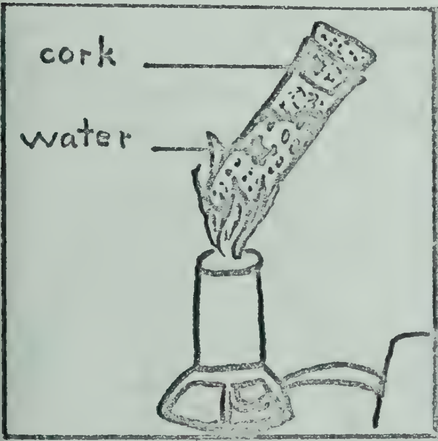

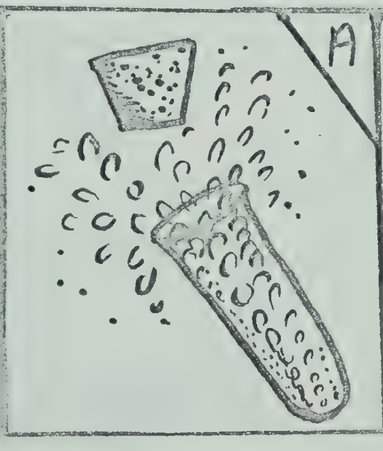

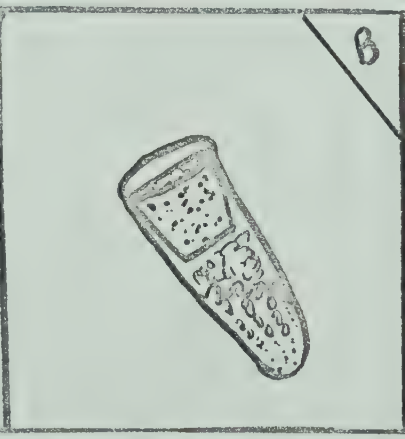

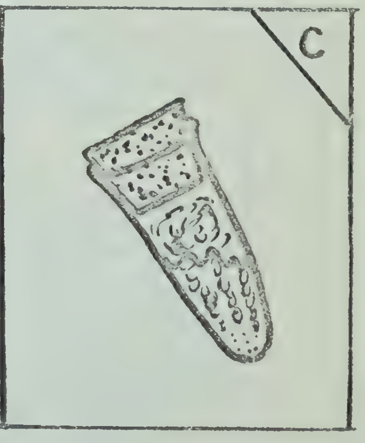

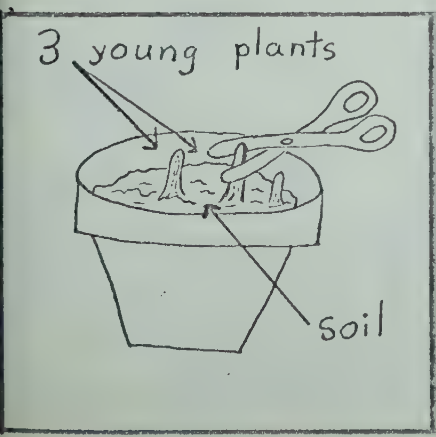

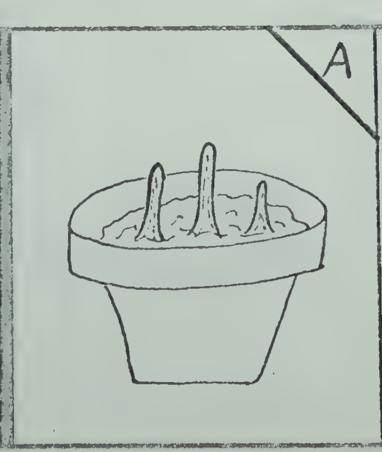

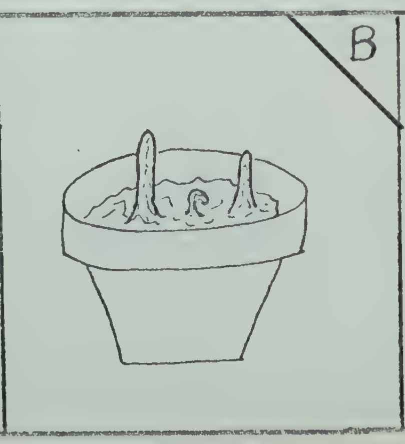

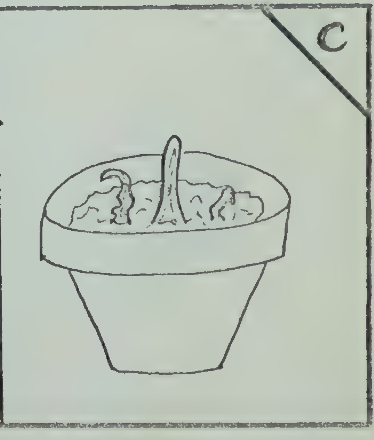

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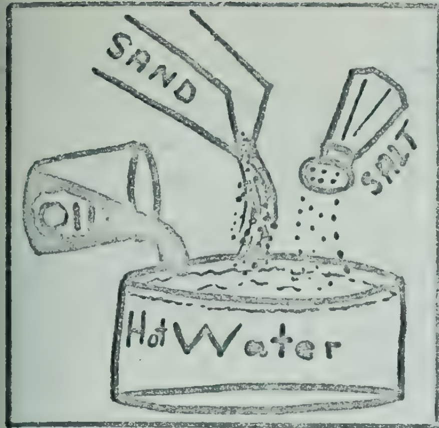

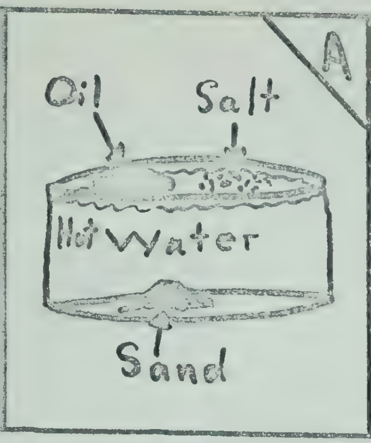

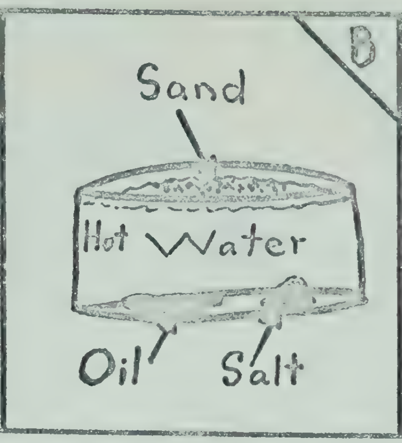

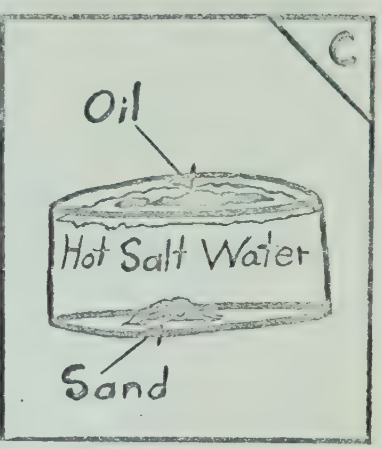

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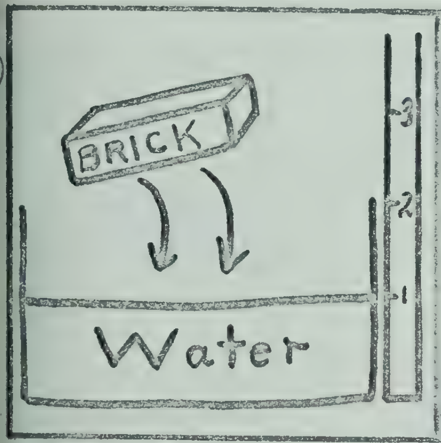

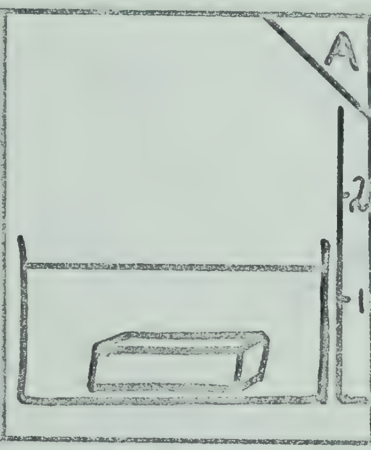

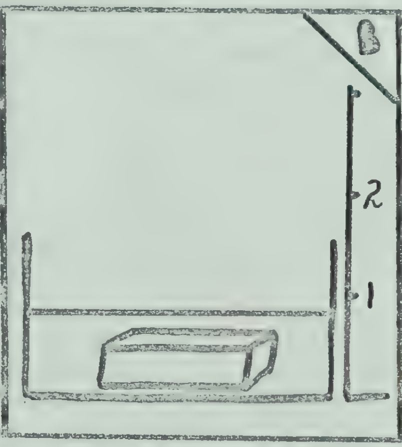

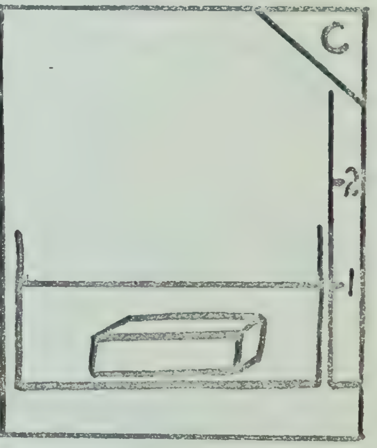

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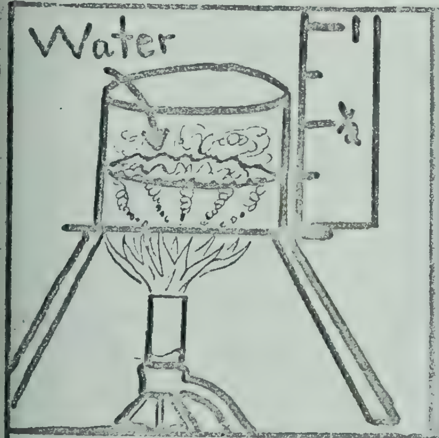

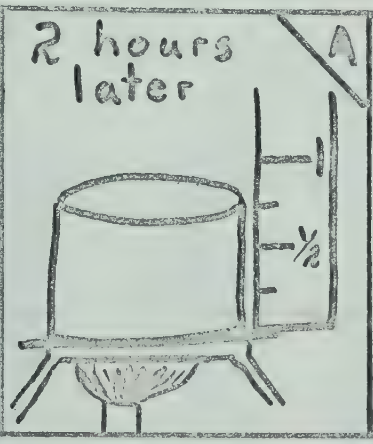

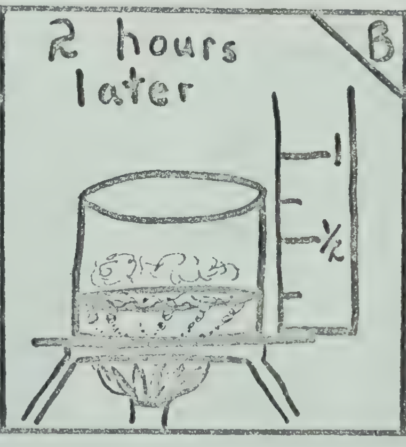

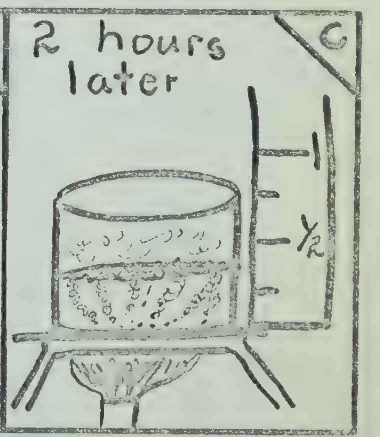

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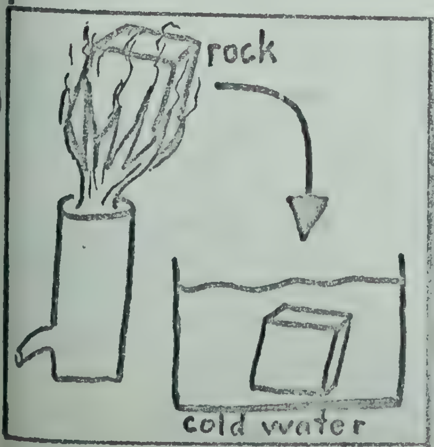

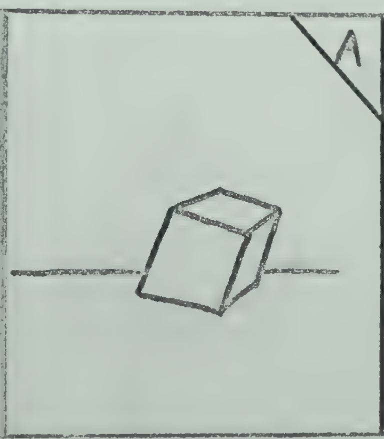

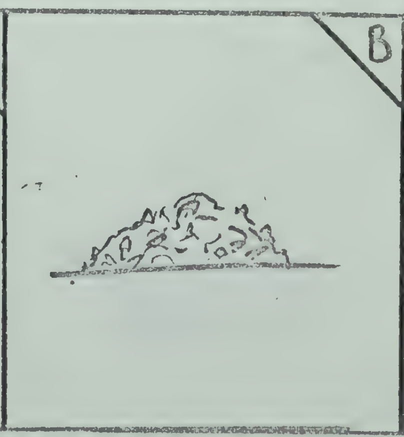

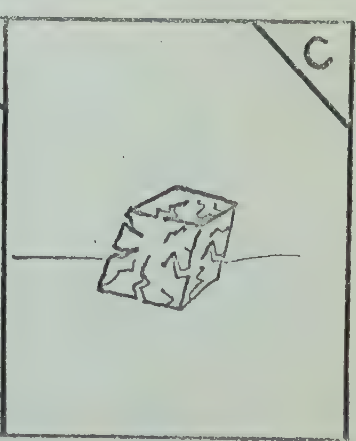

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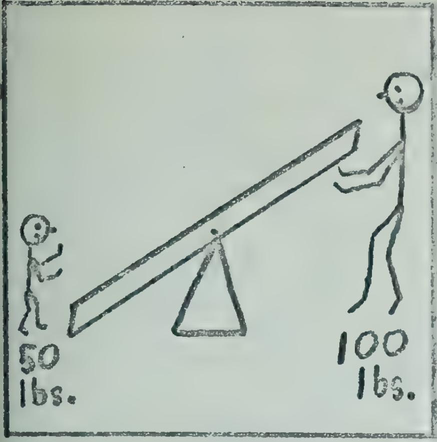

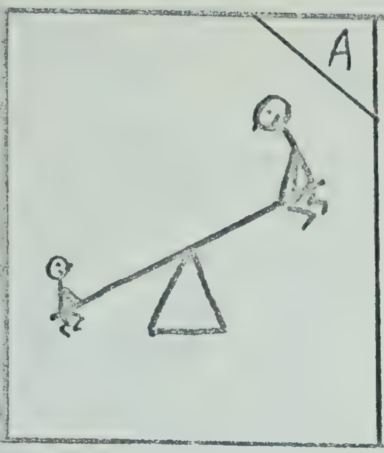

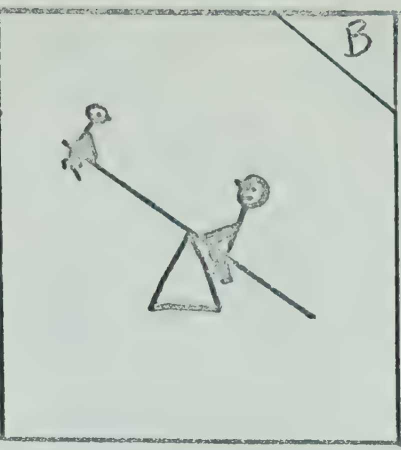

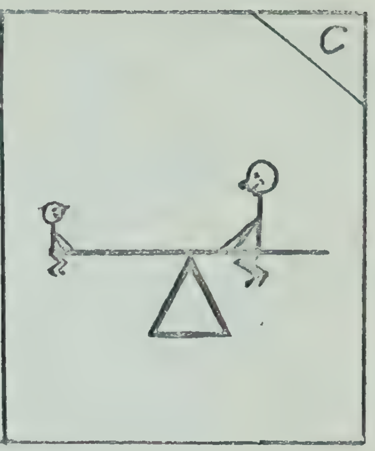

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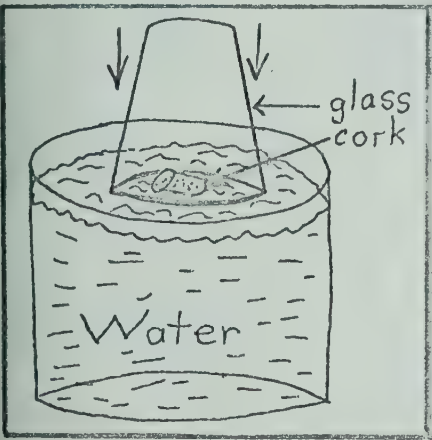

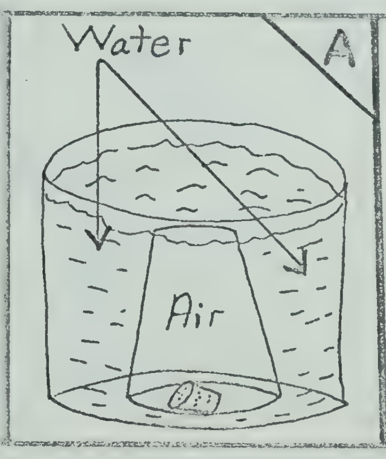

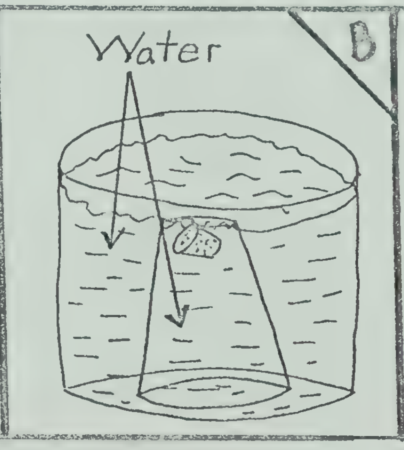

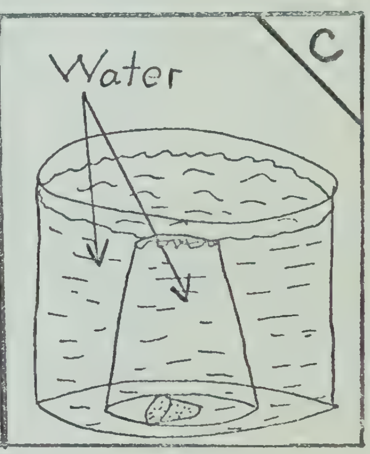

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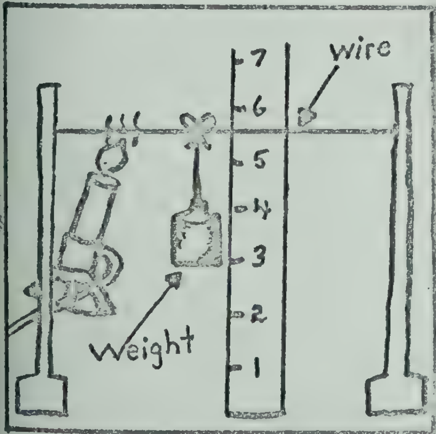

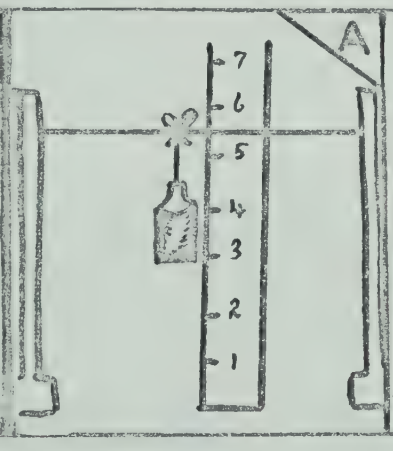

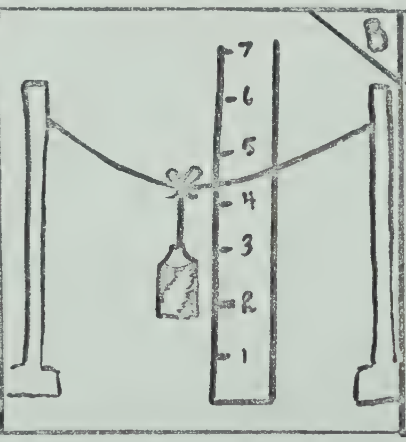

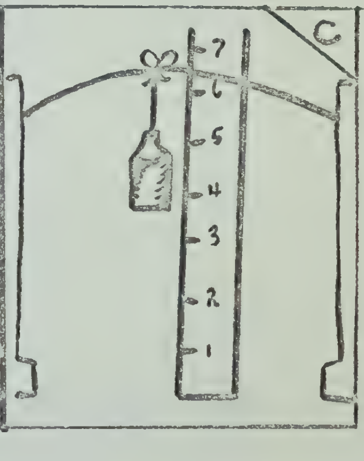

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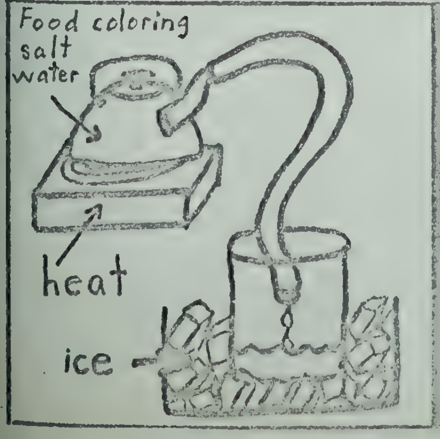

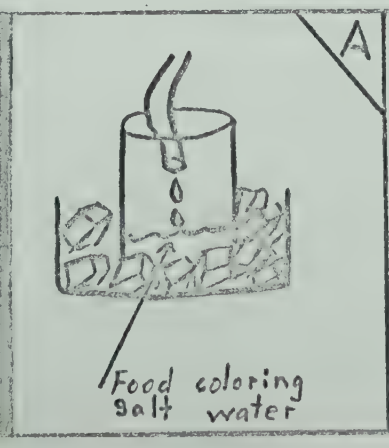

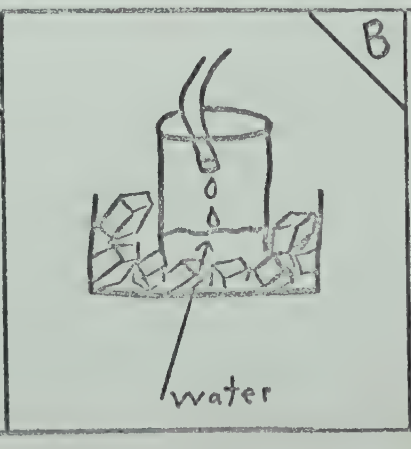

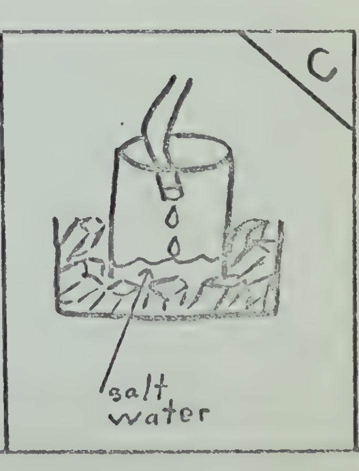

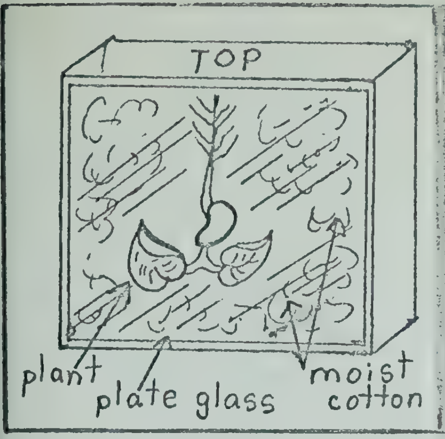

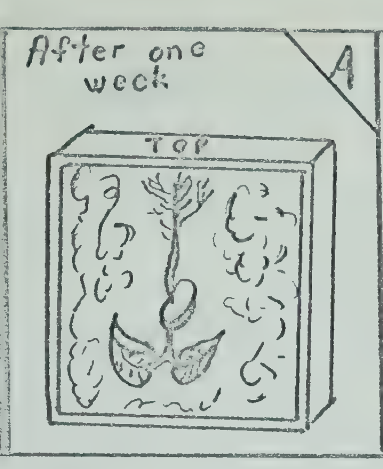

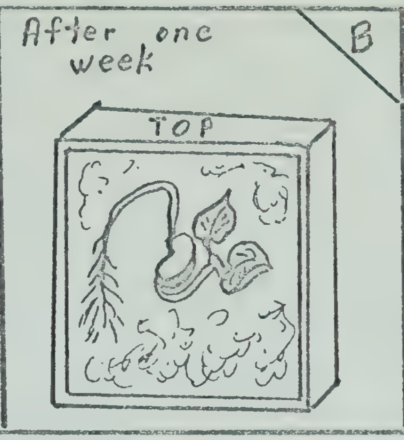

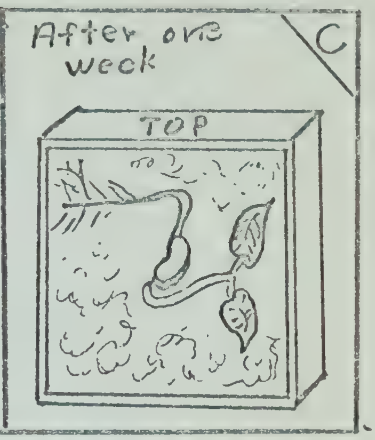

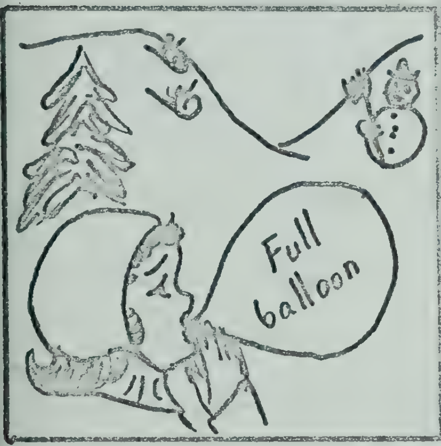

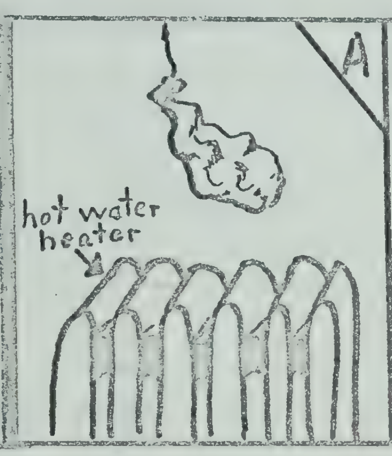

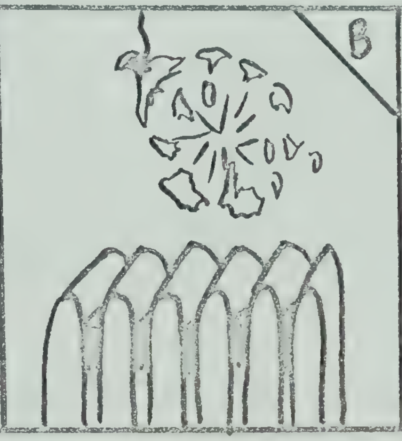

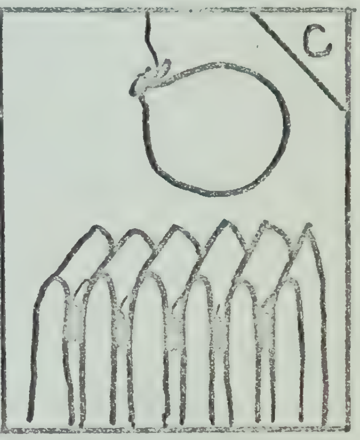

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PICTORIAL SCIENCE TEST

SECTION THREE

Do not write in any way upon the pages of this booklet. Place your answers on the answer sheet in the same way you did in SECTIONS ONE and TWO. Start on number 36.

In each of the following 17 questions you will find three things at the top which are alike in one main way. At the bottom of the question are three other things (A, B, C). Only one of A, B, or C could be put with the group at the top and belongs with them. You are to discover the rule by which the top ones are grouped and then choose one of A, B, or C.

Two sample questions are on the following page.

Example 139

B 2 is the answer because the group members and the walnut are all parts of plants that we eat.

Example 140

Which answer did you mark on your answer sheet?

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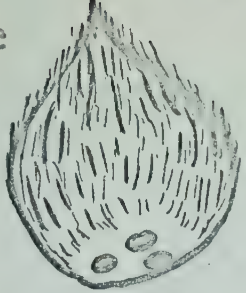
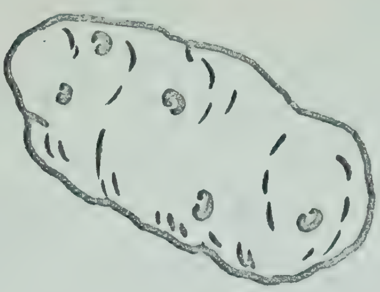
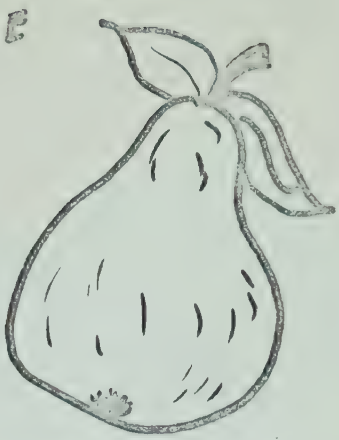
DO NOT MARK THIS PAGE

xample
39







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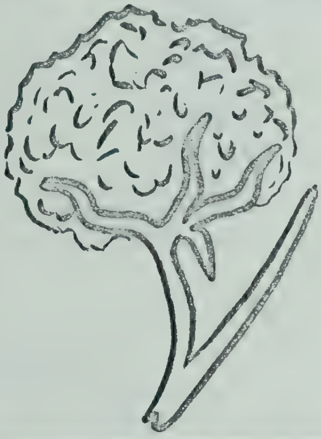

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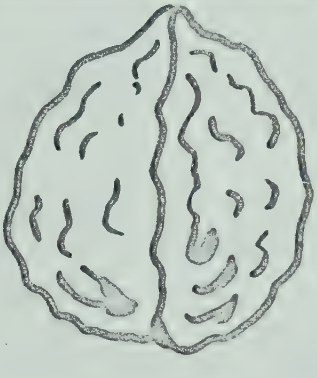

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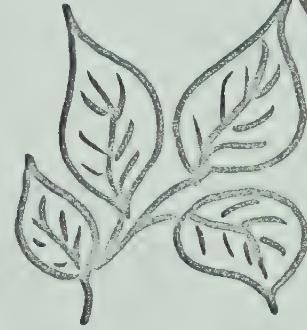

xample
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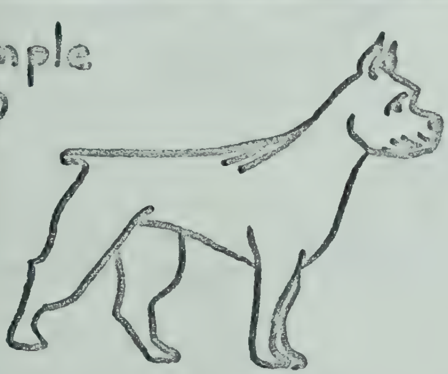

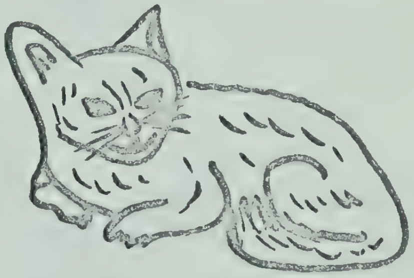

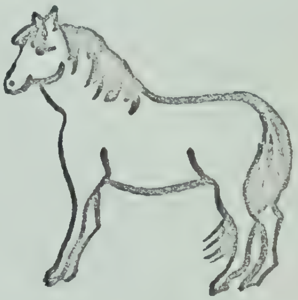

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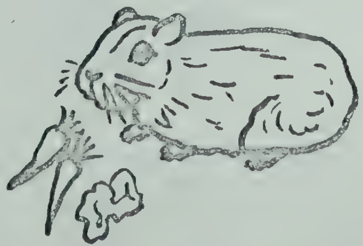

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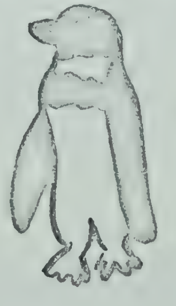

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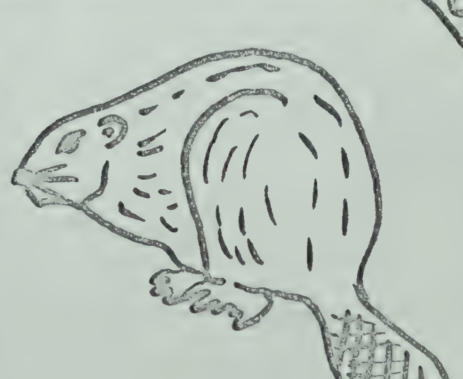

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1
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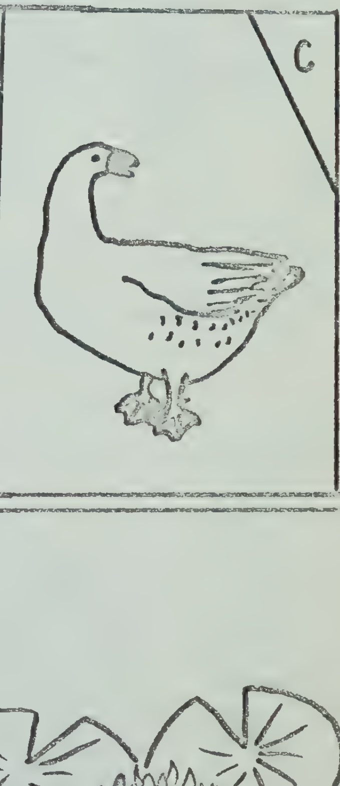
A

B



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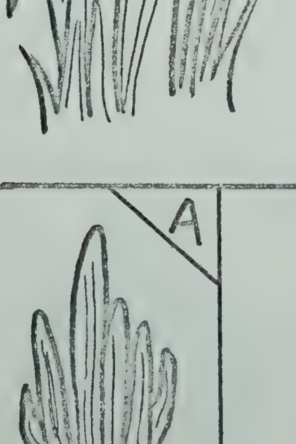

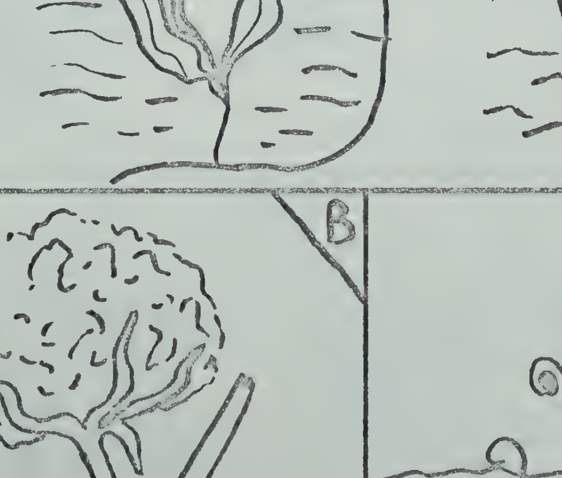

A

B

C

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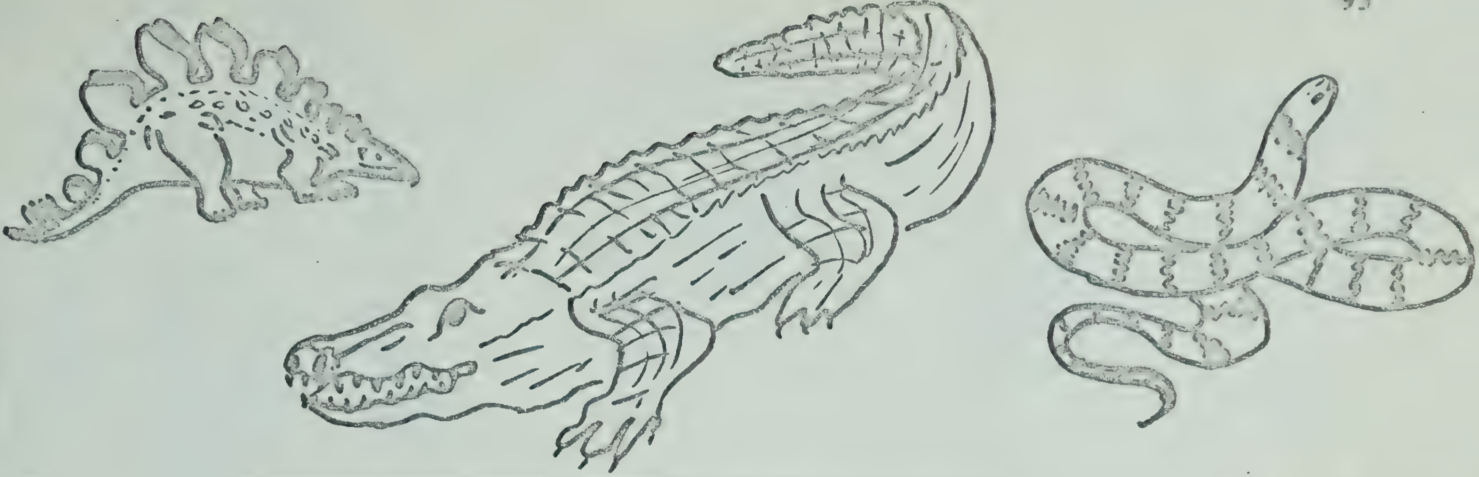

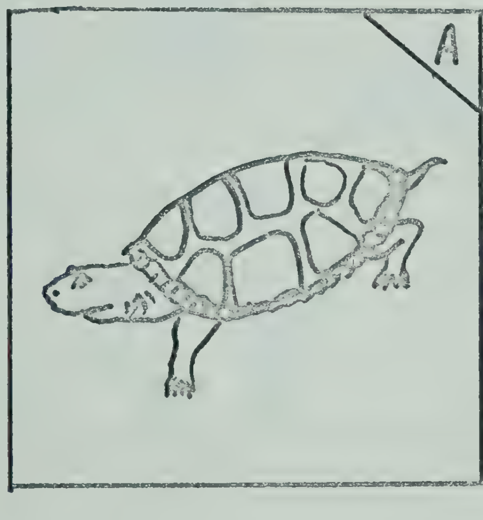
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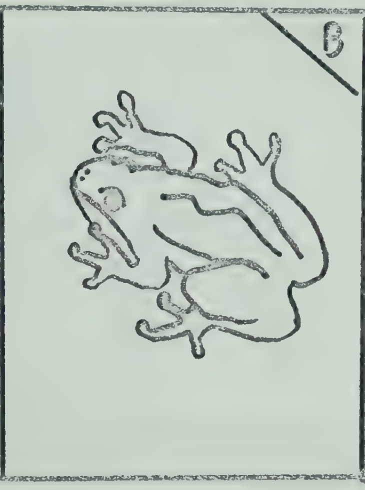
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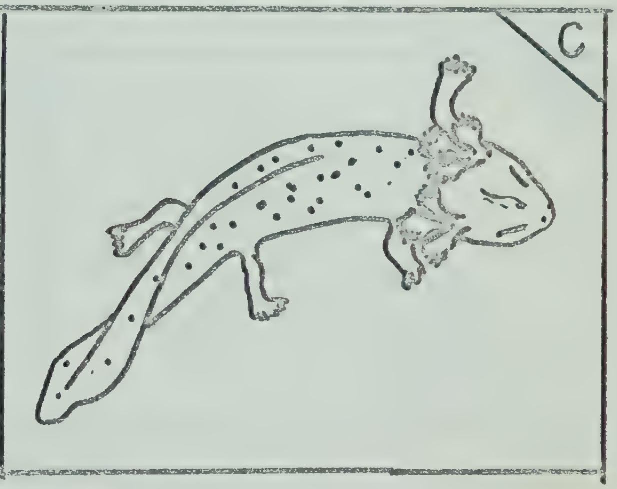
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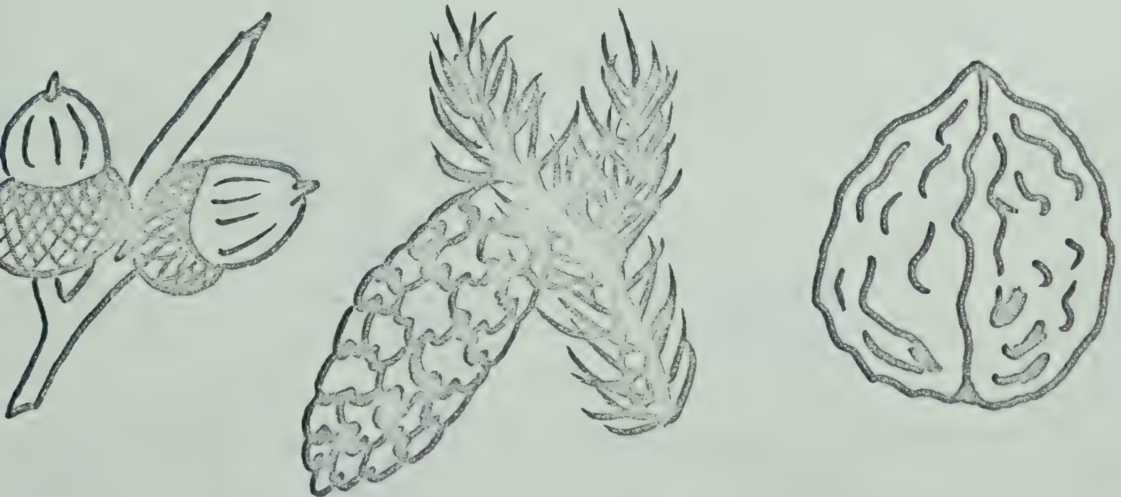

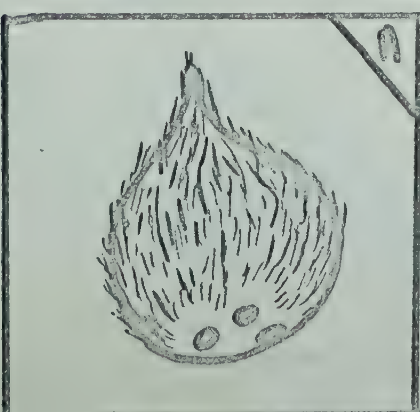
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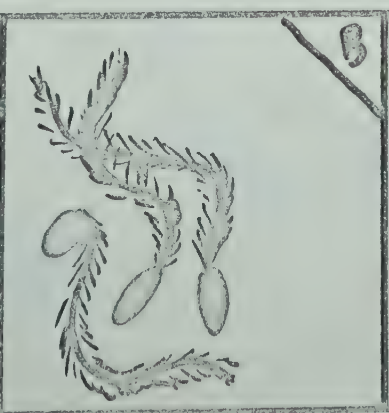
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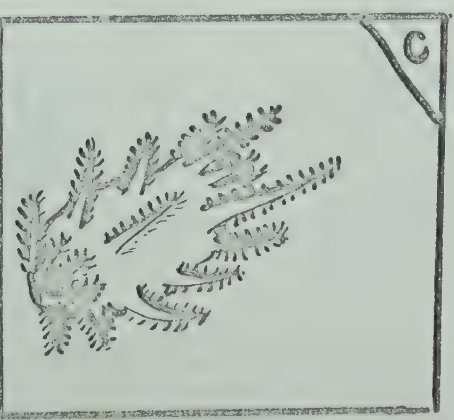
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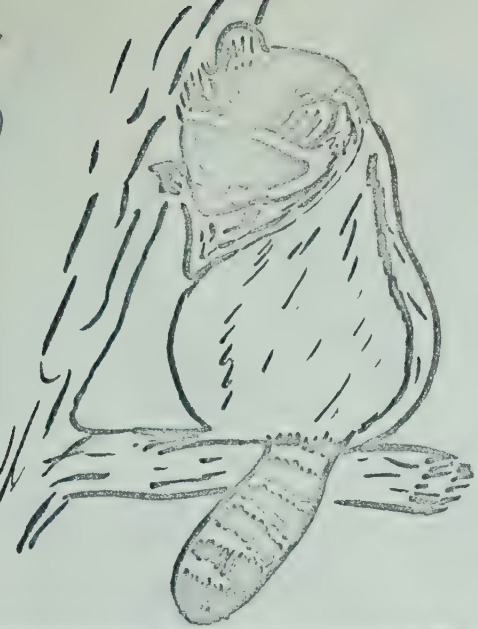

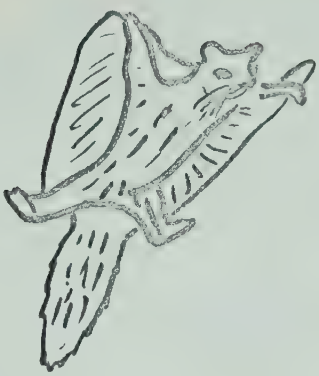

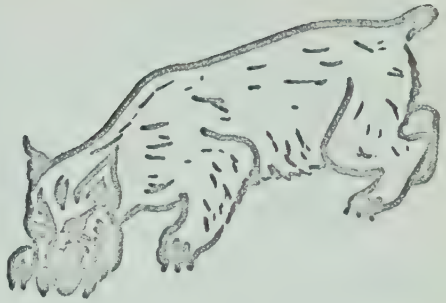

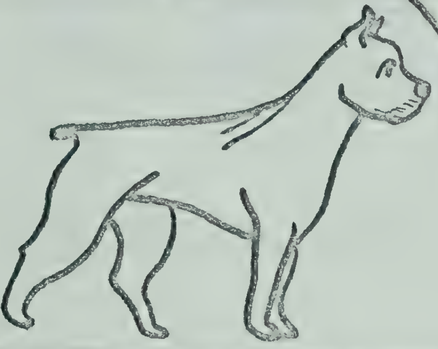

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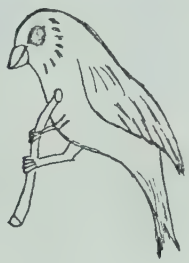

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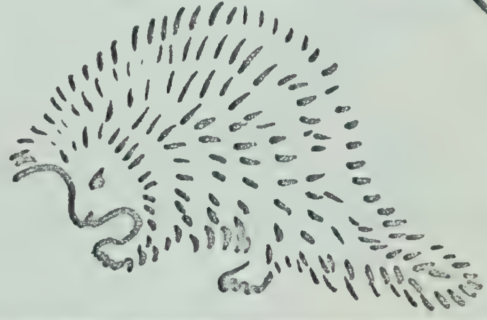

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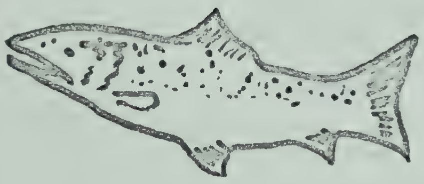

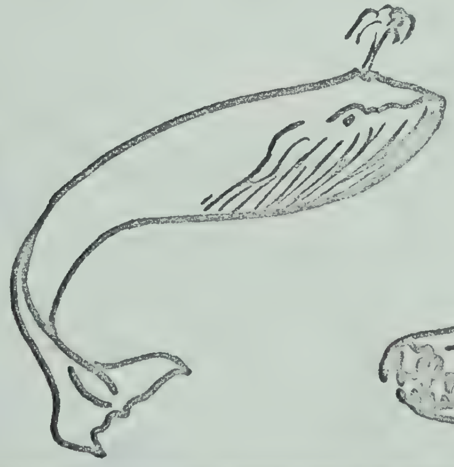

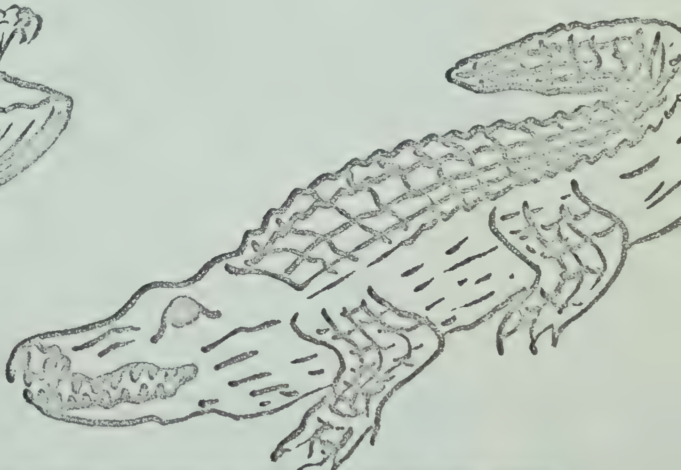

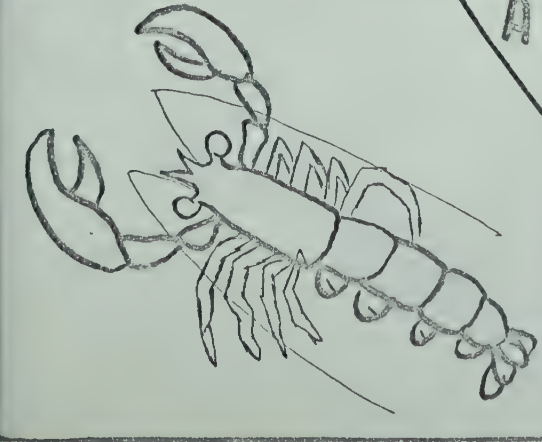

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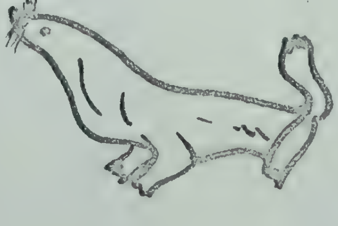

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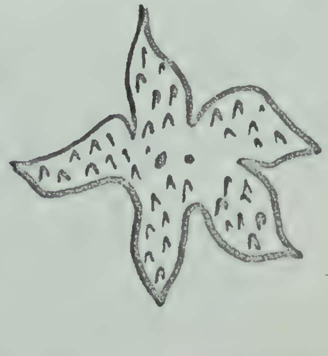

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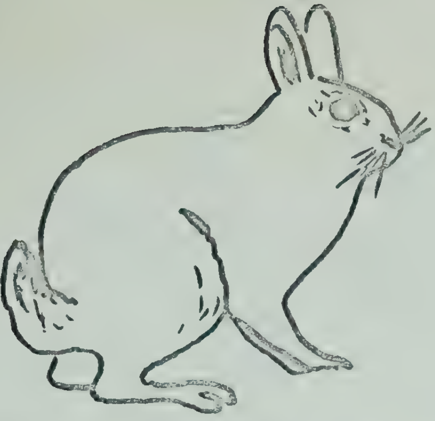

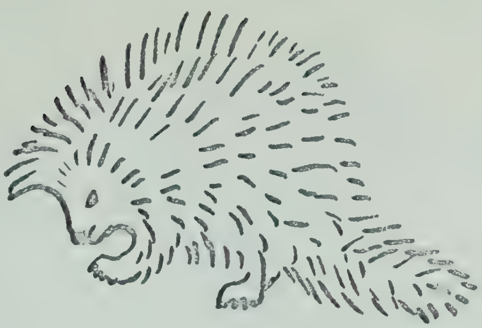

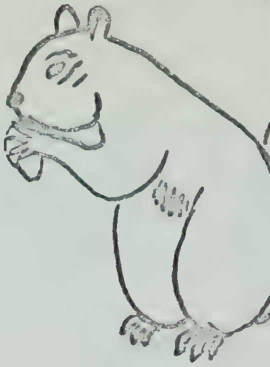

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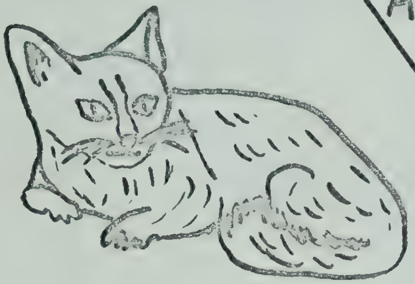

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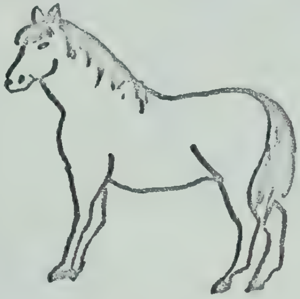

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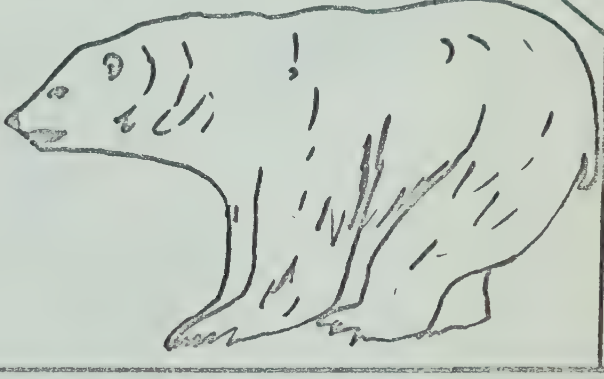

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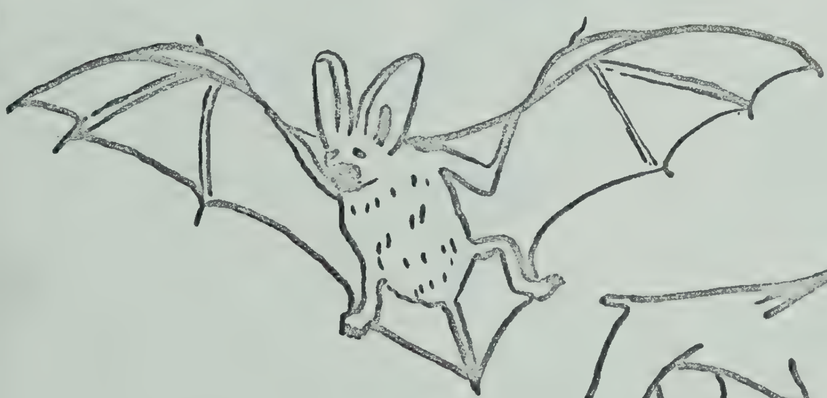

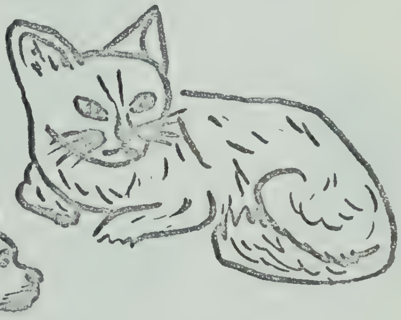

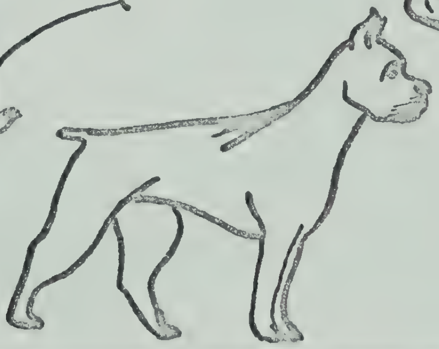

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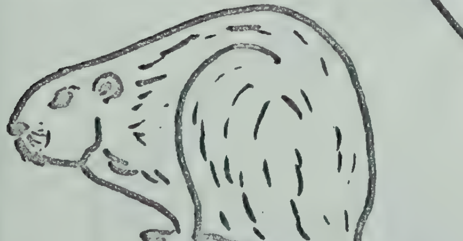

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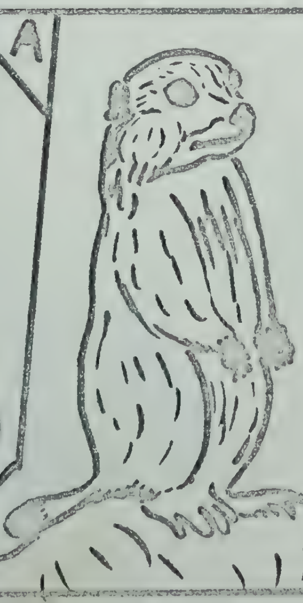

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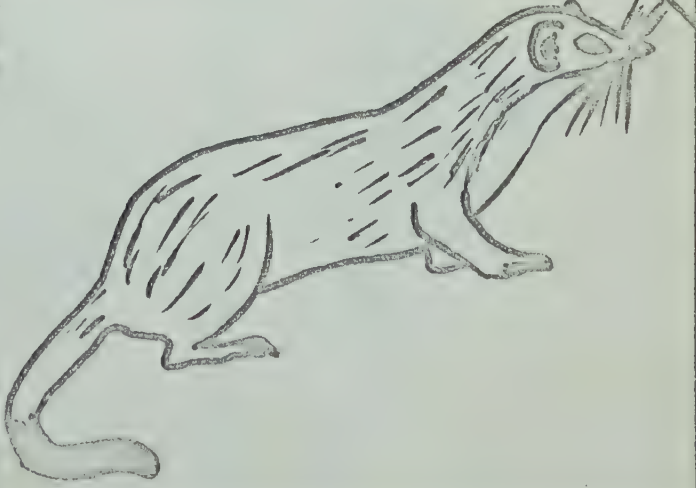

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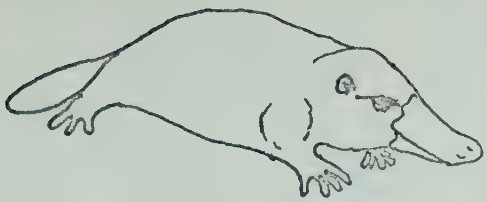

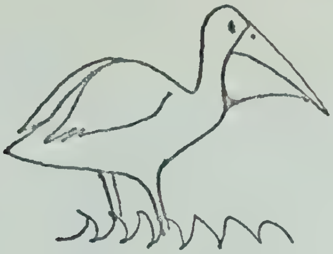

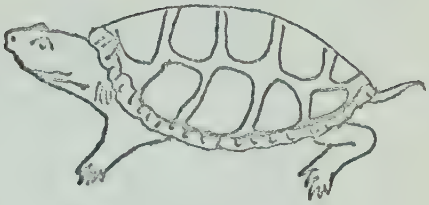

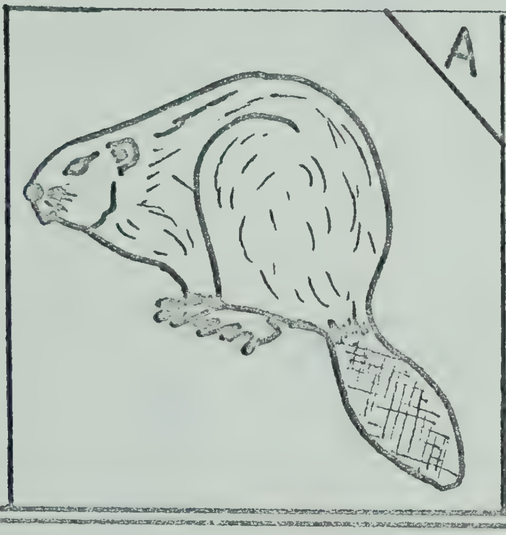

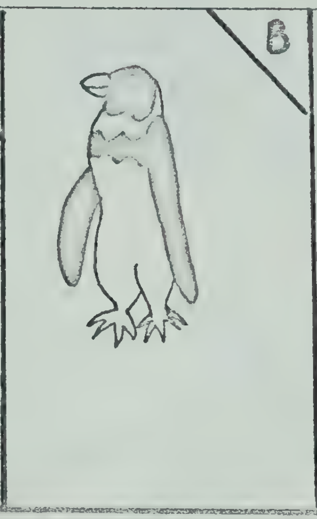

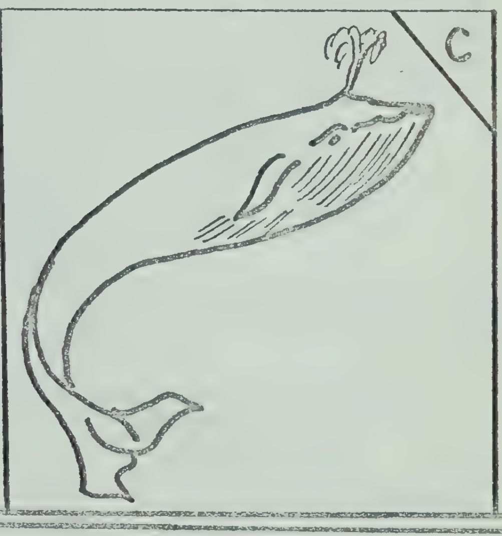

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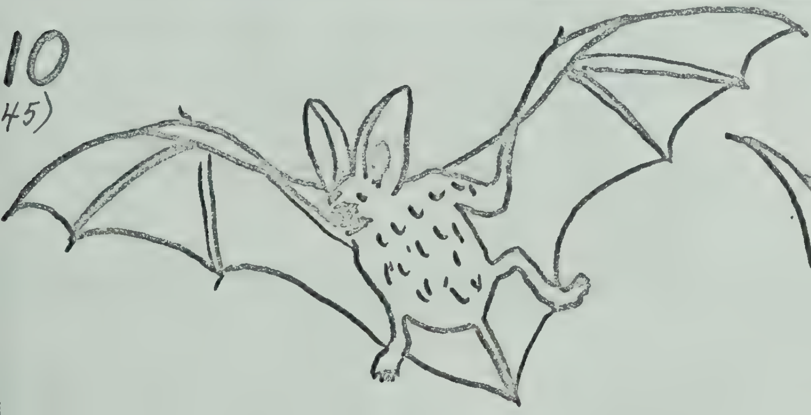

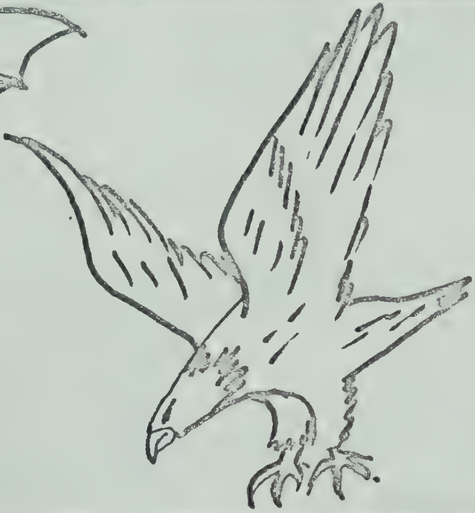

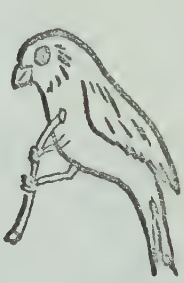

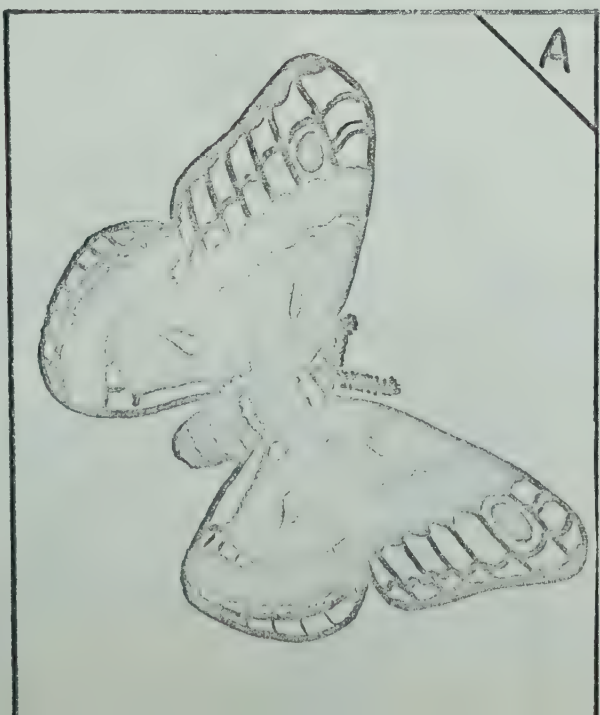

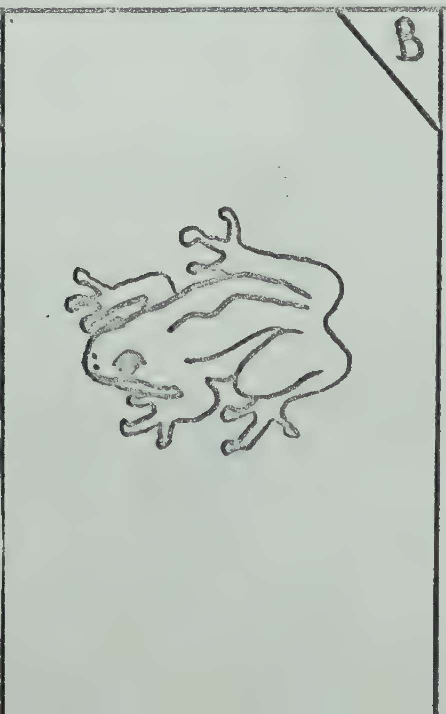

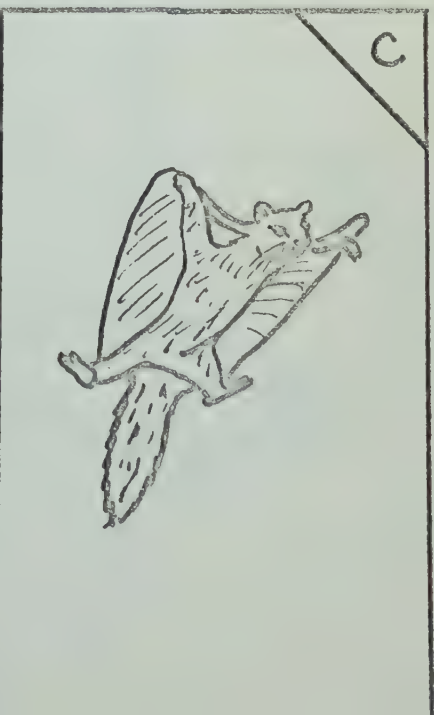

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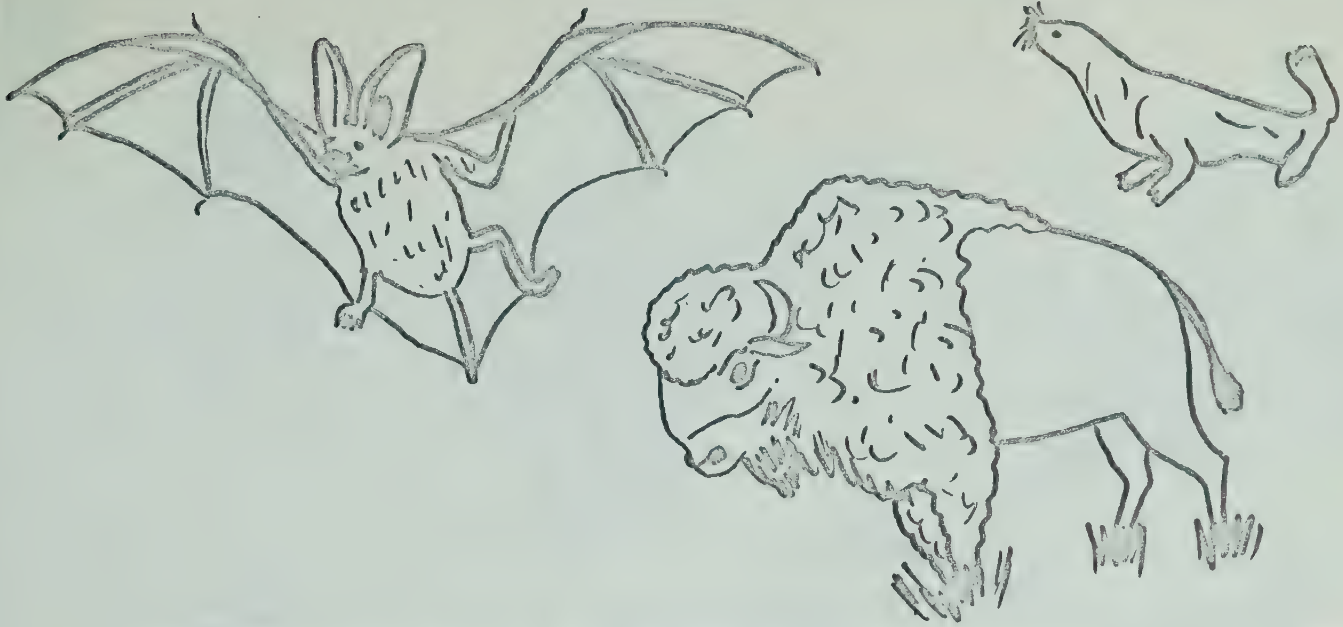

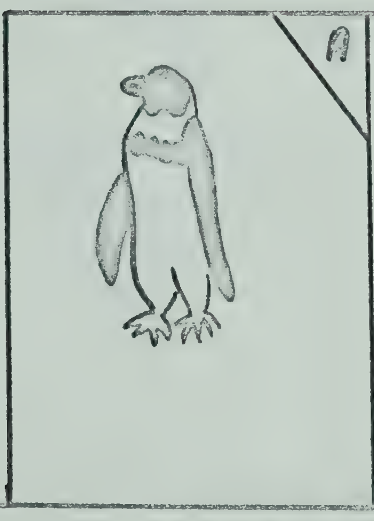

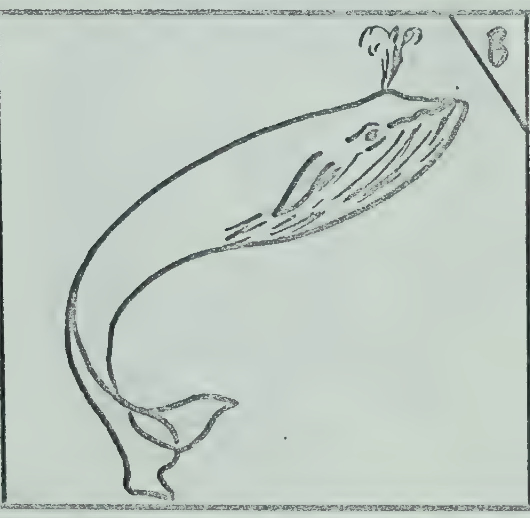

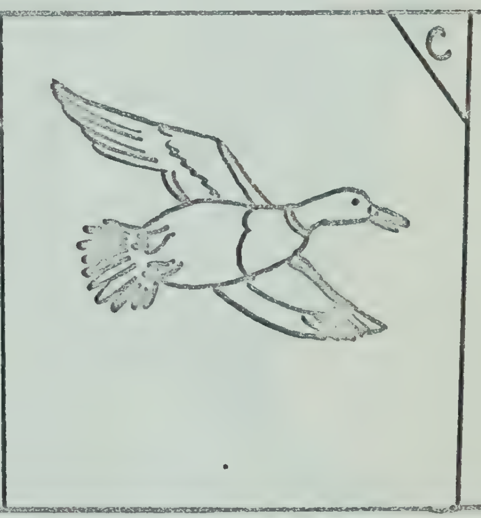

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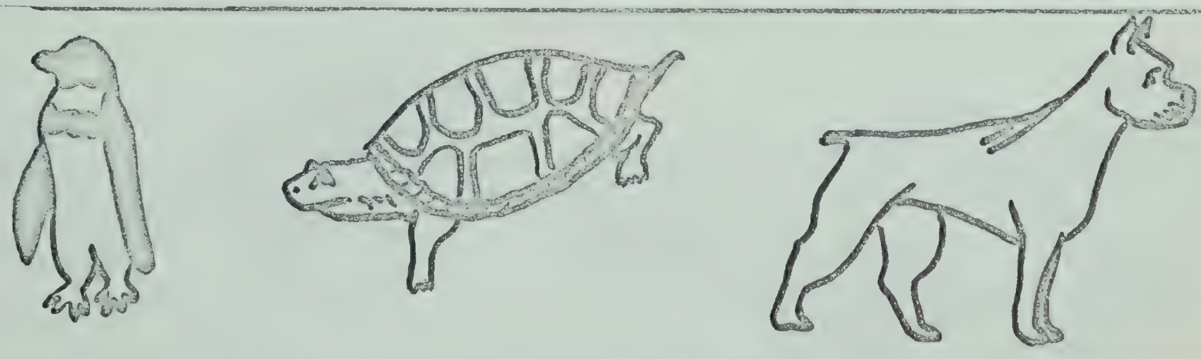

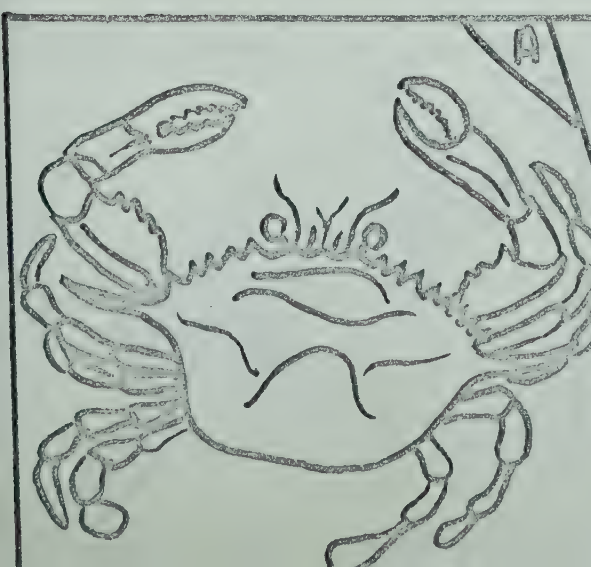

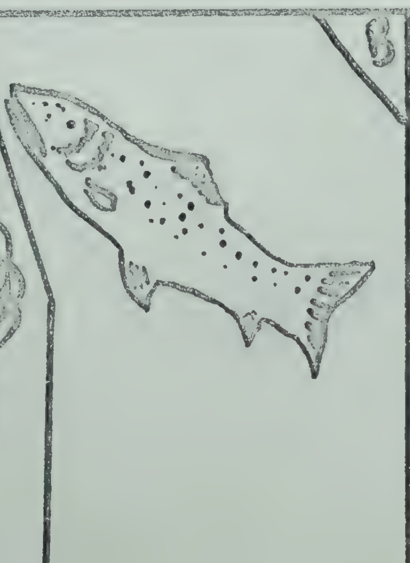

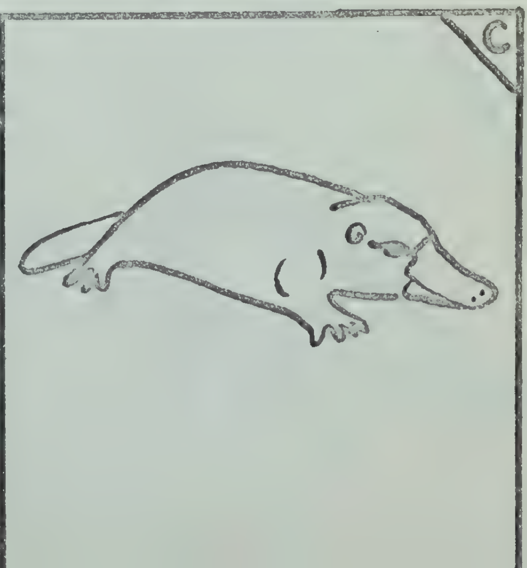

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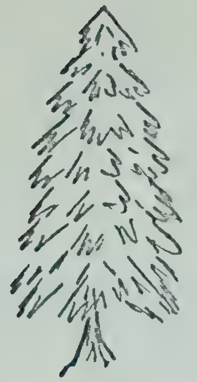

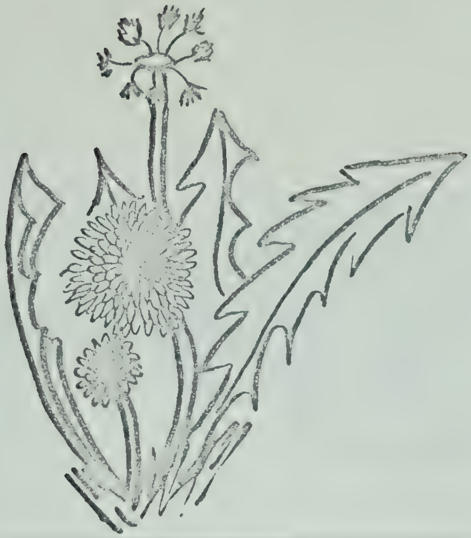

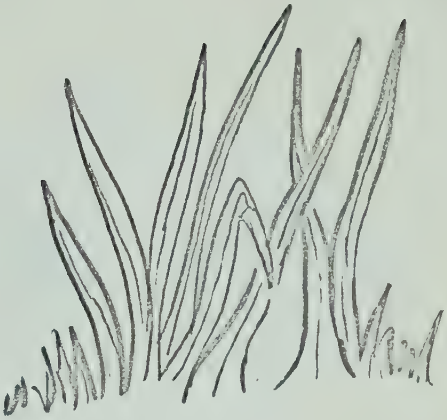

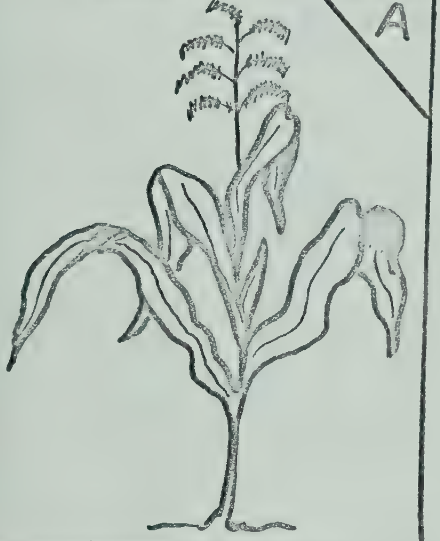

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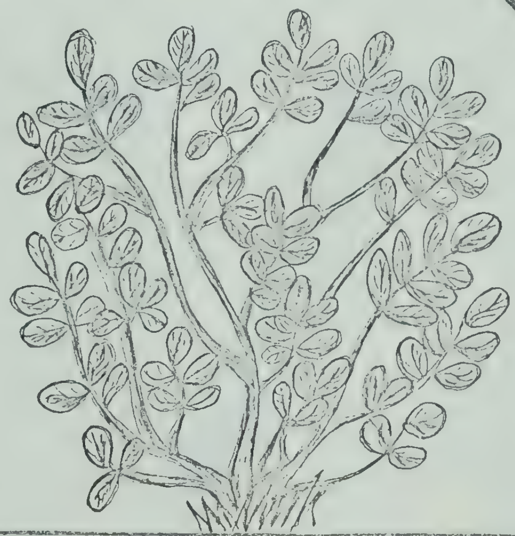

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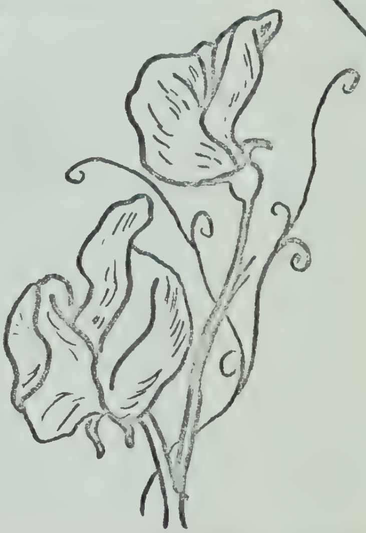

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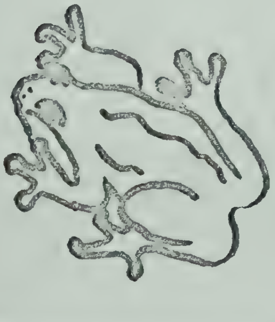

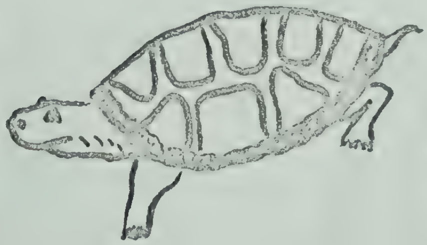

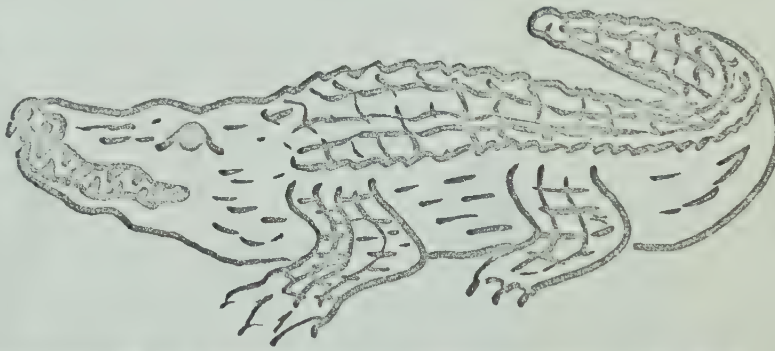

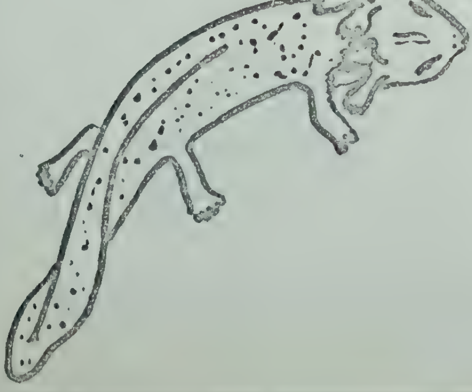

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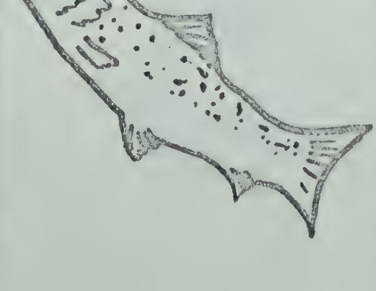

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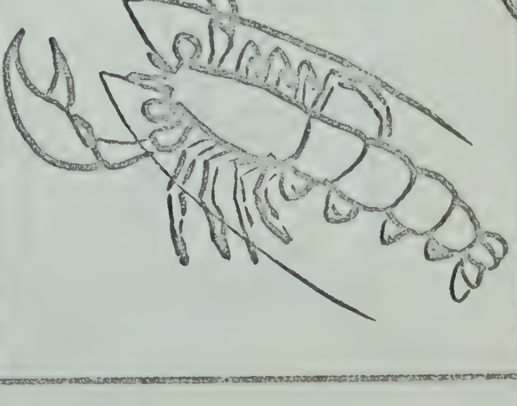

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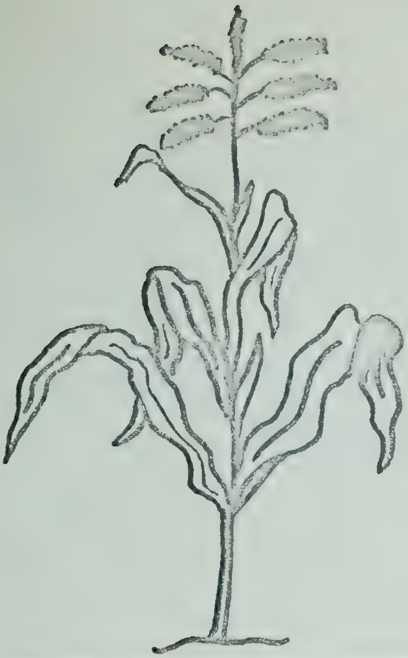

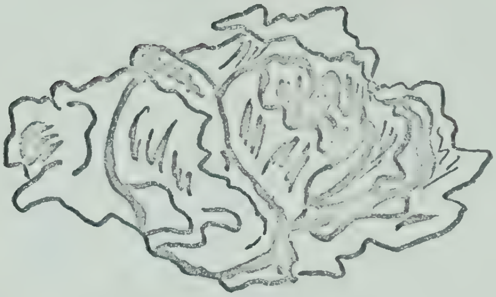

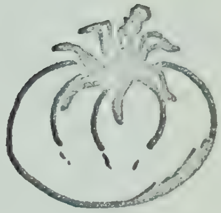

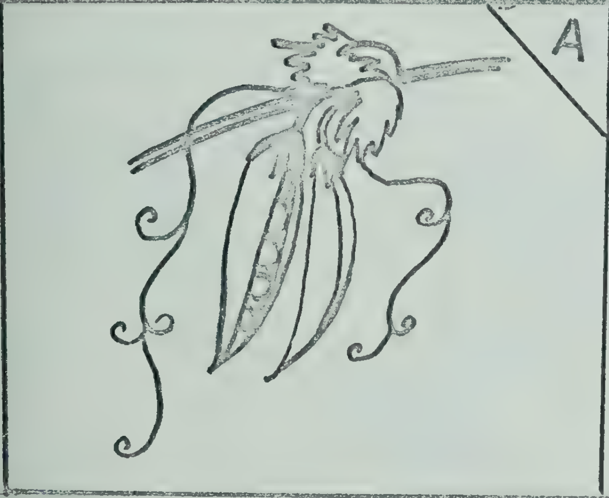
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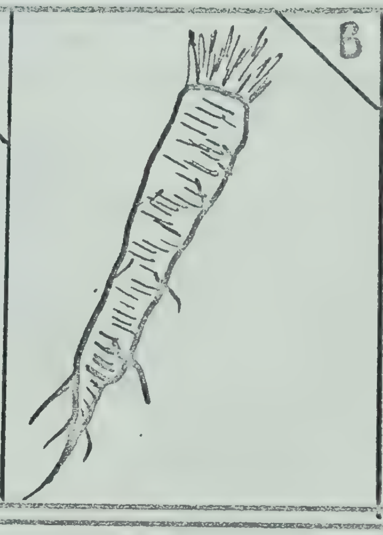
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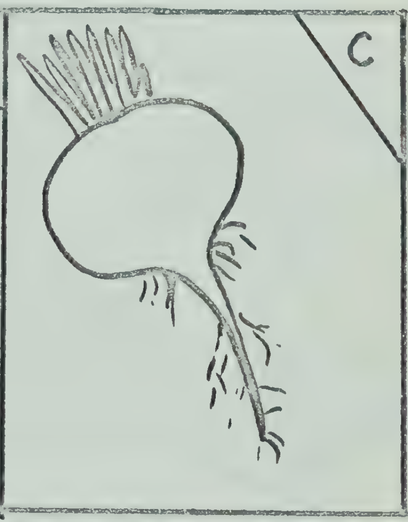
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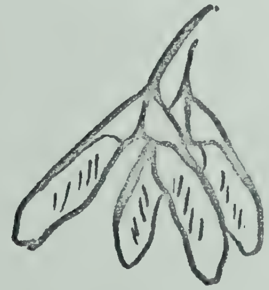

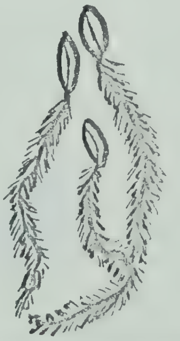

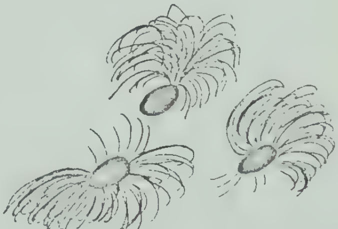

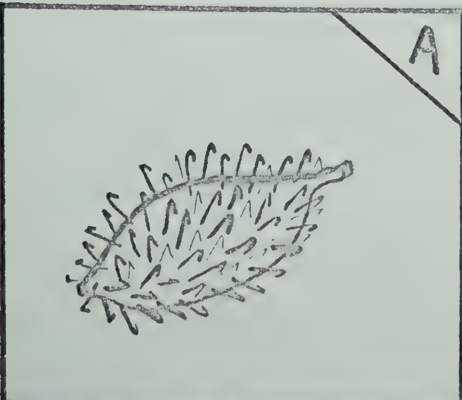
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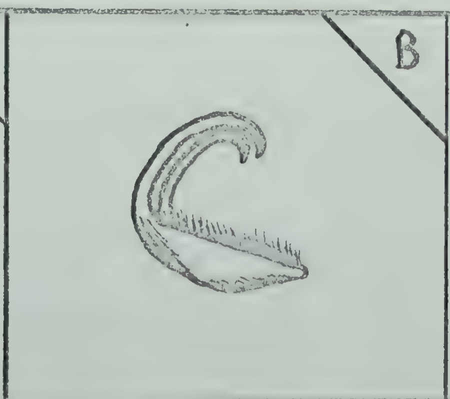
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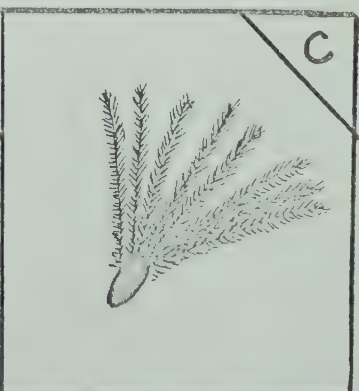
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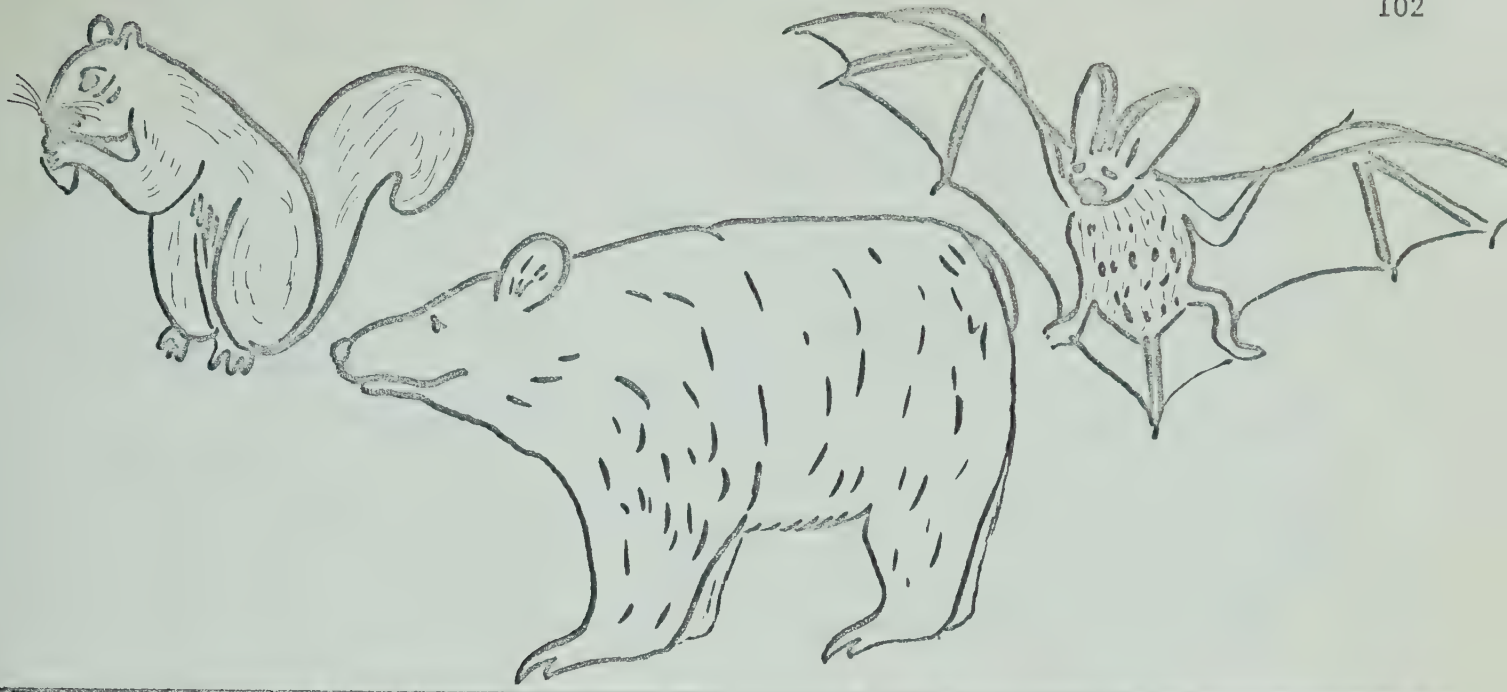

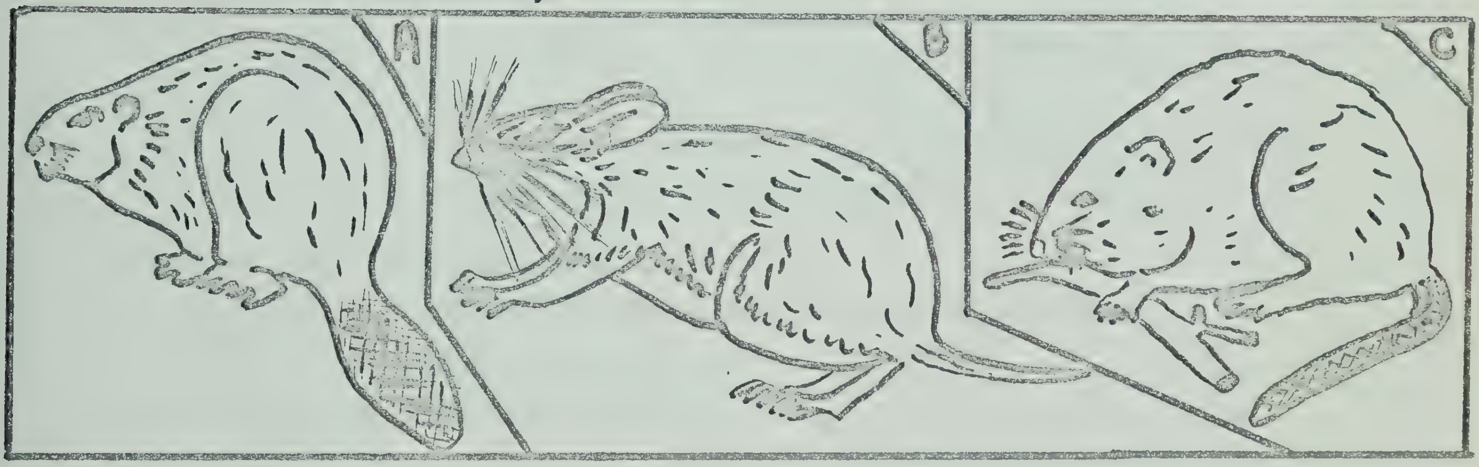

Stop

If you have finished early, you may check your work.
Be sure that any answers you have changed are completely erased on the answer sheet.

READING SCIENCE TEST

SECTION ONE

DO NOT write in any way upon the pages of this booklet. Place your answers on the answer sheet. Start on number one.

You must answer every question. Work as carefully and as quickly as you can.

In each of the following 21 questions, you will be given a problem to solve. It will involve a scientific concept. Only one of the possibilities A, B, or C is the correct solution. On the answer sheet you will see

A 1   B 2   C 3   D 4   E 5   Only spaces A, B or C should

ever be marked. Do not put any marks in spaces D or E. If you wish to change an answer you must erase it completely.

EXAMPLE 135. Edmonton is located

A. in southern Alberta near the Saskatchewan border.

B. in central Alberta.

C. in north-western Alberta.

On the answer sheet beside #135, you should have marked B like this B 2

EXAMPLE 136. When attempting to pull a large nail out of a piece of wood, the tool which will give you the best mechanical advantage is

A. a hammer.

B. a pair of pliers.

C. a crowbar.

Which answer did you choose?

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1. This problem is about the direction of movement of car wheels. Imagine that a tiny car is on your desk, with the front of it facing your left hand.

   A. If the car moved forward, the wheels would turn in the direction of the hands of a clock (clockwise).

   B. If the car were to back up, the wheels would turn in a clockwise direction.

   C. If the car were to back up, the wheels would turn in the opposite direction from the hands of a clock (counter-clockwise).

2. Two weights are suspended by identical metal springs. One weight is 10 pounds and the other weight is 30 pounds.

   A. The 30-pound weight will cause its spring to stretch more than that of the 10-pound weight.

   B. The 10-pound weight will cause its spring to stretch more.

   C. The springs of the 10 and 30-pound weights will stretch the same amount.

3. If a horseshoe magnet were placed in a pile of tacks and then lifted out carefully, the tacks would be clinging to

   A. the two ends of the magnet.

   B. every part of the magnet.

   C. the two ends and the inside edges of the magnet.

4. A wire from a dry cell battery is wound around a nail several times and then connected to one post of a switch. A wire from the other post of the dry cell is attached to the other post of the switch. Some tacks are available near the nail.

   A. When the switch is closed, the nail will pick up tacks.

   B. When the switch is closed, the nail will not pick up tacks.

   C. When the switch is open, the nail will pick up tacks.

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5. Imagine that you are looking at the side of a water wheel which has a huge water pipe opening above it. The water can flow over the top and down the right-hand side of the wheel, or it can flow down the left-hand side of the wheel.

   A. If the water flows over the top and down the right-hand side of the wheel, the wheel will turn clockwise and counter-clockwise.

   B. If the water flows back, over the left-hand side of the wheel, it will turn in a counterclockwise direction.

   C. If the water flows back, over the left-hand side of the wheel, it will turn in a clockwise direction.

6. Four small pieces of wax are stuck in a row, onto a long metal rod, and the end of the rod is then heated. Call the piece of wax nearest the heat number one, and the piece farthest, number four.

   A. Wax piece number three will drop off first.

   B. Wax piece number two will drop off first.

   C. Wax piece number one will drop off first.

7. This problem is about an object's ability to float.

   A. If an egg is placed in salt water, it will not float.

   B. If an egg is placed in fresh water, it will float.

   C. If an egg is placed in salt water, it will float.

8. When a horseshoe magnet is cut in half

   A. the two cut ends both become south poles so that one piece has two north poles, and the other piece has two south poles.

   B. the two cut ends become north and south poles so that one piece has two north poles and the other piece has two south poles.

   C. the two cut ends become north and south poles so that each piece has a north and a south pole, without the original uncut poles changing.

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9. This problem is about the movement of air over a mountain. Imagine a mountain with masses of air moving toward it from the left-hand side.

   A. When warm dry air moves up the left-hand side of the mountain, rain will fall on that side and moist air will move down the other side of the mountain.

   B. When cool dry air moves up one side of the moutain, rain will fall, and moist air will move down the other side.

   C. When warm moist air moves up one side of the mountain, rain will fall, and dry air will move down the other side.

10. Imagine a propeller attached by a rod to a pulley wheel so that both will turn in the same direction. This wheel is attached by a moveable belt, to another pulley wheel. The two pulley wheels will turn in the same direction. A shaft with a rope wound around it in a clockwise direction, is attached to the second pulley wheel. Imagine that the propeller is facing toward you. When the rope is pulled toward the floor,

    A. the two pulley wheels will turn in a clockwise direction, and the propeller will turn in a clockwise direction.

    B. the two pulley wheels will turn in a counter-clockwise direction, and the propeller will turn in a clockwise direction.

    C. the two pulley wheels will turn in a counter-clockwise direction, and the propeller will turn in a counter-clockwise direction.

11. When a mixture of sand, salt and water is poured through filter paper

    A. water will collect in the dish beneath the filter paper.

    B. sand and water will collect in the dish beneath the filter paper.

    C. salt and water will collect in the dish beneath the filter paper.

12. A large round metal container had three one-inch-wide holes drilled on the side of it, one near the bottom, one in the middle and one near the top. They were plugged with cork and the can was completely filled with water. Then the corks were pulled out at the same time.

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12. A. The water sprayed out the greatest distance from the bottom hole, les from the middle hole and the least distance from the top hole.

    B. The water sprayed out the greatest distance from the top hole, less from the middle hole and the least distance from the bottom hole.

    C. The water sprayed out an equal distance from all three holes.

13. Imagine the sun being near your right hand, and the earth situated near your left. As the earth is revolving, causing day and night, it is turning

    A. in a left to right direction.

    B. in a right to left direction.

    C. in right and left directions, alternately.

14. A pulley is a simple machine and can be used for lifting heavy objects.

    A. Using two pulleys, working together, a force of 50 pounds would be needed to left a 50-pound weight.

    B. Using one pulley, a force of 30 pounds would be needed to lift a 50-pound weight.

    C. Using two pulleys, working together, a force of 30 pounds would be needed to lift a 50-pound weight.

15. This problem is about the manner in which a flashlight will give light.

    A. When the batteries are attached to each other and to the bulb, and the switch is closed, the bulb will light.

    B. When the batteries are attached to each other, to the case and the bulb, and the switch is closed, the bulb will not light.

    C. When the batteries are attached to each other, to the case and the bulb, and the switch is closed the bulb will light.

16. Two wood screws of equal length and width are about to be screwed into a piece of wood. Screw number one has a wide pitch and screw number two has a narrow pitch. After they have both been turned around three times,

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16. A. Screw number two will be deeper into the wood.

B. Screw number one will be deeper into the wood.

C. The screws will both be equally as far into the wood.

17. One wire from a dry cell is connected to a socket with a light bulb and then to one end of a

A. piece of paper. When the other wire from the dry cell is connected to the other end of the paper, the bulb will light.

B. nail. When the other wire from the dry cell is connected to the other end of the nail, the bulb will not light.

C. piece of glass. When the other wire from the dry cell is connected to the other end of the glass, the bulb will not light.

18. Water will condense into droplets on the outside of a glass container when

A. a glass of cold water is placed in a hot room.

B. a glass of hot water is placed in a hot room.

C. a glass of hot water is placed in a cold room.

19. Two boxes of equal size and depth were filled with sand and placed in the sun. A thermometer was placed on each box of sand and the bulb of each was pushed into the sand. Box number one was left flat on the ground. Box number two was propped up at a 45° angle. They were left in the sun for a few hours. When the temperature of each thermometer was checked,

A. the temperature in box number one was 80°F and in box number two it was 50°F.

B. the temperature in box number one was 80°F and in box number two it was 80°F.

C. the temperature in box number one was 50°F and in box number two it was 80°F.

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20. This problem is about the strength of a strong magnet. When the ends of a strong horseshoe magnet are placed against one side of a plate of

    A. glass, and an iron ring is hung a few inches away from the other side of the glass, the magnet can attract the ring through the glass.

    B. glass, and an iron ring is hung a few inches from the other side of the glass, the magnet will not be able to attract the ring through the glass.

    C. iron, and an iron ring is hung a few inches away from the other side of the iron plate, the magnet will be able to attract the iron ring through the plate.

21. This problem is about the flow of an electric current. A dry cell battery has been connected to a socket with a light bulb in it.

    A. If the two wires are frayed so that the metal wire is exposed, and the two exposed metal parts touch each other, the light will go on.

    B. If the two wires are frayed, but the exposed metal parts do not touch each other, the light will go on.

    C. If the two wires touch each other but are not frayed, the light will not go on.

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You may go on to Section 2, now.

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READING SCIENCE TEST

SECTION TWO

Continue through these 1 4questions in the same way you did those in Section one. Place your answers on the answer sheet, starting with number 22.

(1.) 22 A glass container, filled with water, has a rubber ball, a nail and a piece of wood lying on the bottom of it. When a magnet is lowered into the container of water, it will be able to attract

A. the nail and the piece of wood.

B. none of the objects.

C. the nail.

(2.) 23 If you pound a magnet several times with a hammer, it

A. will be able to pick up tacks.

B. will not be able to pick up iron filings.

C. will be able to pick up iron filings.

(3.) 24 If a test tube three-quarters full of water is solidly corked, and then the bottom is heated until the water boils very rapidly, the cork will

A. pop out of the test tube.

B. be sucked deeper into the test tube.

C. remain in the same position.

(4.) 25 Three very young plants are growing in a clay pot. They are about one inch above the soil. The top of one of the plants is cut off with a pair of scissors.

A. All three plants will continue to grow normally.

B. two of the plants will grow normally but the cut plant will die.

C. The cut plant will grow normally but the two uncut plants will die.

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5. (26) If small amounts of sand, oil and salt are poured into hot water.

A. the sand will sink to the bottom, but the oil and salt will float on the top.

B. the oil and salt will sink to the bottom but the sand will float on the top.

C. the sand will sink to the bottom, the salt will dissolve, and the oil will float on the top.

6. (27) If a small brick is placed in one inch of water, so that it is covered, the water level will

A. rise to 1 1/2 inches.

B. lower to less than one inch.

C. remain the same.

7. (28) If one-quarter inch of water is boiled for two hours, the water

A. will evaporate completely.

B. level will remain the same.

C. will increase to almost one-half inch of water.

8. (29) When a solid piece of rock is heated to a very high temperature and then plunged into cold water, it will

A. remain unchanged in any way.

B. crumble into a pile of dust and small rock pieces.

C. develop cracks all over.

9. (30) Two children would like to play together on a teeter totter. One child weighs 50 pounds and the other weighs 100 pounds.

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9. A. When both children sit, one at each end of the board, the small child's end will rest on the ground. The larger child will be held up in the air.

   B. When the small child is sitting at the very end of the board and the larger child is sitting halfway along his half of the board, the larger child's end of the board will be resting on the ground.

   C. When the small child sits at the very end of the board, and the larger child sits halfway along his half of the board, the board will balance.

(10.) 31 A container filled with water has a cork floating on top of the water. An empty glass is inverted over the cork and is then pushed down until it touches the bottom of the large container. As a result

   A. the cork will rest on the bottom of the container and the glass over it will be filled with air.

   B. the glass will fill completely with water and the cork will be at the top of the water, within the glass.

   C. the glass will be filled with water and the cork will rest on the bottom of the container.

(11.) 32 A wire is strung fairly tightly between two posts. A metal weight is hung from the wire by a string. According to a ruler placed next to the weight the bottom of the weight is three inches above the table top. Now the metal wire is heated by a strong flame. As a result.

   A. the weight will remain three inches above the table.

   B. the weight will move down to about two inches above the table.

   C. the weight will move up to about three and one-half inches above the table.

(12.) 33 Food coloring, salt and water are mixed together and then boiled in a closed kettle. The kettle has only one opening. A tube from this opening leads to a container which is sitting in a pan of ice water. Droplets of liquid will be collected in the container. The liquid collected will contain

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12. A. food coloring, salt, and water.

    B. water.

    C. salt and water.

13. (34) A bean seed sprouted so that it had a short root and two small green leaves attached. It had been placed root-end up on some moist cotton, in a closed box. Let's say that it is pointing toward the top of the box. The front of the box was covered with plate glass so that the plant was easily seen. The box was then placed upright and left for two weeks. After two weeks the seedling was observed and

    A. was found to be in the same position it was two weeks ago.

    B. the root had turned around and was pointing toward the bottom of the box, while the leaves had turned around and were growing in the direction of the top of the box.

    C. the root and the leaves were pointing toward the sides of the box, rather than the top or bottom.

14. (35) When a balloon is blown up very full, outside in the wintertime, and then taken into a very warm room,

    A. it will shrivel.

    B. it will explode.

    C. it will remain unchanged.

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READING SCIENCE TEST

SECTION THREE

Do not write in any way upon the pages of this booklet. Place your answers on the answer sheet the same way you did in Sections one and two. Start on number 36.

In each of the following 17 questions you will find three things at the top which are alike in one main way. At the bottom of each question are three other things, A, B, or C. Only one of A, B, or C could be put with the group above and belongs with them. You are to discover the rule by which the top ones are grouped and then choose one of A, B, or C, and place your answer on the answer sheet.

Example 139. Coconut, potato, pear

A. cotton plant B. walnut C. oak leaves

B. is the answer because the group members and the walnut are all parts of plants, that we eat.

You should mark B like this B 2

on your answer sheet beside 139

Example 140. Dog, cat, horse

A. guinea pig, B. penquin C. beaver

Which answer did you mark on your answer sheet?

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1. ostrich, eagle, penguin
(36)
   A. seal
   B. bat
   C. goose

2. bullrushes, kelp, water lily
(37)
   A. cactus
   B. cotton plant
   C. pond fern

3. dinosaur, alligator, snake
(38)
   A. turtle
   B. frog
   C. salamander

4. acorn, evergreen seed cone, walnut
(39)
   A. coconut
   B. clemantis seeds
   C. cocklebur

5. racoon, flying squirrel, lynx
(40)
   A. dog
   B. sparrow
   C. porcupine

6. fish, whale, alligator
(41)
   A. lobster
   B. seal
   C. starfish

7. rabbit, porcupine, squirrel
(42)
   A. cat
   B. horse
   C. polar bear

8. bat, dog, cat
(43)
   A. beaver
   B. gopher
   C. weasel

9. duckbill platypus, pelican, turtle
(44)
   A. beaver,
   B. penguin
   C. whale

10. bat, eagle, sparrow
(45)
   A. moth
   B. frog
   C. flying squirrel

11. bat, bison, seal
(46)
   A. penguin
   B. whale
   C. duck

12. penguin, turtle, dog
(47)
   A. crab
   B. fish
   C. duckbill platypus

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(13.) pine tree, dandelion, grass
48
- A. corn
- B. shrub
- C. sweet pea

(14.) frog, turtle, alligator
49
- A. salamander
- B. fish
- C. lobster

(15.) corn, lettuce, tomato
50
- A. peas
- B. carrot
- C. beet

(16.) maple seed, clemantis seeds, milkweed seeds
51
- A. cocklebur seed
- B. devil's-claw seed
- C. thistle seed

(17.) squirrel, black bear, bat
52
- A. beaver
- B. mouse
- C. muskrat

STOP

If you have finished early you may check your work.
Be sure that any answers you have changed are completely erased on the answer sheet.

ITEM ANALYSIS

Summary of responses, Item difficulty and Item discrimination (Form 2)

Item no.	Group		Option A	Option B	Option C	Item Difficulty	(Biserial correl.) Item Discrimination
1	Pictorial (P)	High (H)	.17	*.79	.04	P .467	P 0.501
		Low (L)	.62	.19	.19		
	Reading (R)	High (H)	.17	*.56	.28	R .476	R 0.187
		Low (L)	.17	.43	.39		
2	P	H	*.88	.0	.13	P .800	P .389
		L	.71	.10	.19		
	R	H	*.89	.06	.06	R .701	R .357
		L	.78	.22	0.0		
3	P	H	*.71	.17	.13	.725	- 0.048
		L	.71	.19	.10		
	R	H	.61	.17	.22	.514	.180
		L	.48	.22	.30		
4	P	H	*.83	.04	.13	.508	.492
		L	*.24	.24	.52		
	R	H	.56	0.0	.44	.238	.439
		L	.13	.26	.61		
5	P	H	.0	*.96	.04	.675	.454
		L	.24	*.57	.14		

(* indicates correct answer)

Item No.	Group		Option A	Option B	Option C	Item Difficulty	(Biserial correl.) Item Discrimination
5	R	H	0.0	*.78	.22	.505	.370
		L	.13	.35	.52		
6	P	H	.17	.13	*.71	.708	.265
		L	.14	.38	.48		
	R	H	.06	0.0	*.94	.771	.352
		L	.26	.04	.70		
7	P	H	.17	.04	*.79	.458	.477
		L	.48	.38	.14		
	R	H	.11	.06	*.83	.505	.393
		L	.57	.22	.22		
8	P	H	.13	.21	*.67	.383	.237
		L	.19	.52	.29		
	R	H	.06	.11	*.83	.638	.244
		L	.09	.35	.57		
9	P	H	.13	.0	*.88	.617	.411
		L	.19	.29	.48		
	R	H	.11	.17	*.72	.486	.267
		L	.17	.39	.43		
10	P	H	*.88	.04	.08	.600	.332
		L	.48	.38	.14		
	R	H	*.33	.06	.61	.238	.167
		L	.13	.57	.30		

(* indicates correct answer)

Item No.	Group		Option			Item Difficulty	(Biseroal correl.) Item Discrimination
			A	B	C		
11	P	H	.46	.13	*.42	.425	.166
		L	.33	.29	.33		
	R	H	.61	.06	*.33	.381	.006
		L	.22	.43	.35		
12	P	H	*.46	.08	.46	.292	.226
		L	.24	.10	.67		
	R	H	*.56	.33	.11	.495	.217
		L	.39	.35	.26		
13	P	H	*.83	.17	.0	.650	.289
		L	.67	.19	.14		
	R	H	*.50	.33	.17	.343	.332
		L	.13	.52	.35		
14	P	H	.13	.13	*.75	.442	.456
		L	.43	.38	.14		
	R	H	.11	.33	*.56	.400	.214
		L	.39	.22	.39		
15	P	H	.08	.08	*.83	.675	.218
		L	.14	.19	.67		
	R	H	.11	.50	*.39	.295	.220
		L	.22	.70	.09		
16	P	H	.0	*.63	.38	.258	.542
		L	.19	.10	.71		

(* indicates correct answer)

Item No.	Group		Option			Item	(Biserial correl.)
			A	B	C	Difficulty	Item Discrimination
16	R	H	.33	*.50	.17	.371	.206
		L	.35	.26	.39		
17	P	H	.13	.42	*.46	.208	.499
		L	.14	.76	.10		
	R	H	.11	.17	*.72	.352	.462
		L	.13	.57	.30		
18	P	H	*.54	.42	.04	.333	.311
		L	.24	.52	.24		
	R	H	*.61	.17	.22	.505	.196
		L	.52	.09	.39		
19	P	H	*.54	.25	.21	.492	.222
		L	.38	.38	.24		
	R	H	*.39	.06	.56	.295	.063
		L	.26	.30	.43		
20	P	H	*.63	.08	.29	.442	.282
		L	.43	.10	.43		
	R	H	*.56	.06	.39	.295	.427
		L	.17	.52	.30		

(* indicates correct answer)

Item No.	Group		Option			Item	(Biserial correl.)
			A	B	C	Difficulty	Item Discrimination
21	P	H	.04	*.79	.13	.417	.661
		L	.38	.05	.52		
	R	H	.44	*.44	.11	.314	.246
		L	.48	.09	.43		
22	P	H	.08	.04	*.88	.758	.308
		L	.19	.29	.52		
	R	H	0.0	.28	*.72	.648	.365
		L	.17	.48	.35		
23	P	H	.25	*.38	.38	.250	.239
		L	.38	.19	.43		
	R	H	.11	*.39	.50	.400	-0.052
		L	.22	.43	.35		
24	P	H	*1.00	.0	.0	.958	.402
		L	.90	.10	.0		
	R	H	*1.0	.0	.0	.876	.572
		L	.57	.17	.26		
25	P	H	.25	*.67	.08	.658	.058
		L	.19	.52	.29		
	R	H	.33	*.56	.11	.467	.173
		L	.30	.35	.30		
26	P	H	.04	.0	*.96	.842	.374
		L	.10	.14	.71		

(* indicates correct answer)

Item No.	Group		Option			Item Difficulty	(Biserial correl.) Item Discrimination
			A	B	C		
26	R	H	.11	.0	*.89	.771	.259
		L	.35	.04	.61		
27	P	H	*.92	.0	.08	.792	.343
		L	.57	.10	.29		
	R	H	*.94	.06	.0	.752	.479
		L	.48	.22	.30		
28	P	H	*.83	.04	.13	.517	.520
		L	.29	.38	.33		
	R	H	*1.0	.0	.0	.733	.495
		L	.52	.17	.30		
29	P	H	.13	.04	*.83	.550	.484
		L	.52	.24	.24		
	R	H	.22	.06	*.72	.629	.219
		L	.39	.17	.43		
30	P	H	.08	.08	*.83	.567	.454
		L	.14	.52	.33		
	R	H	.0	.06	*.89	.505	.539
		L	.13	.57	.30		
31	P	H	*.67	.33	.0	.317	.589
		L	.10	.71	.19		
	R	H	*.67	.28	.06	.314	.494
		L	.22	.39	.39		

(* indicates correct answer)

				Option		Item	(Biserial correl.)
Item No.	Group		A	B	C	Difficulty	Item Discrimination
32	P	H	.17	*.83	.0	.758	.151
		L	.14	.62	.14		
	R	H	.11	*.78	.11	.590	.401
		L	.26	.39	.35		
33	P	H	.38	*.54	.08	.325	.242
		L	.43	.33	.19		
	R	H	.33	*.50	.17	.276	.132
		L	.30	.43	.26		
34	P	H	.21	*.67	.13	.558	.254
		L	.48	.33	.19		
	R	H	.11	*.50	.39	.495	.264
		L	.35	.26	.39		
35	P	H	.33	*.63	.04	.642	.176
		L	.10	.48	.38		
	R	H	.22	*.72	.06	.543	.329
		L	.39	.30	.30		
36	P	H	.0	.21	*.79	.617	.181
		L	.19	.24	.57		
	R	H	.0	.0	*1.0	.781	.237
		L	.13	.13	.74		
37	P	H	.0	.0	*1.00	.925	.459
		L	.10	.10	.81		

(* indicates correct answer)

				Option		Item	(Biserial correl.)
Item No.	Group		A	B	C	Difficulty	Item Discrimination
37	R	H	.06	.0	*.94	.762	.432
		L	.13	.30	.57		
38	P	H	*.54	.08	.38	.325	.225
		L	.24	.14	.62		
	R	H	*.39	.06	.56	.248	.285
		L	.17	.26	.57		
39	P	H	*.92	.08	.0	.808	.307
		L	.67	.24	.10		
	R	H	*.50	.50	.0	.524	.008
		L	.65	.22	.13		
40	P	H	.08	.08	*.83	.625	.291
		L	.14	.29	.57		
	R	H	.11	.06	*.83	.657	.305
		L	.26	.26	.48		
41	P	H	.33	*.67	.0	.508	.256
		L	.29	.43	.29		
	R	H	.06	*.83	.11	.467	.540
		L	.35	.26	.39		
42	P	H	.38	*.08	.54	.100	-0.058
		L	.33	.0	.67		
	R	H	.56	*.11	.33	.162	-0.087
		L	.30	.22	.43		

(* indicates correct answer)

Item No.	Group		Option A	 B	 C	Item Difficulty	(Biserial correl.) Item Discrimination
43	P	H	.17	.38	*.46	.400	.238
		L	.29	.43	.29		
	R	H	.06	.39	*.56	.352	.205
		L	.17	.43	.39		
44	P	H	.29	*.58	.13	.458	.192
		L	.33	.29	.38		
	R	H	.0	*.89	.11	.667	.275
		L	.30	.52	.17		
45	P	H	*.75	.0	.25	.592	.163
		L	.52	.05	.43		
	R	H	*.50	.0	.50	.295	.302
		L	.26	.04	.70		
46	P	H	.29	*.33	.38	.267	.083
		L	.33	.24	.43		
	R	H	.06	*.56	.39	.333	.302
		L	.26	.22	.52		
47	P	H	.08	.08	*.83	.633	.327
		L	.24	.38	.38		
	R	H	.11	.17	*.72	.486	.318
		L	.26	.48	.26		
48	P	H	.25	*.67	.08	.517	.255
		L	.33	.33	.0		

(* indicates correct answer)

Item No.	Group		Option A	B	C	Item Difficulty	(Biserial correl.) Item Discrimination
48	R	H	.06	*.89	.06	.695	.186
		L	.13	.65	.22		
49	P	H	*.75	.08	.17	.583	.363
		L	.33	.33	.29		
	R	H	*.78	.06	.17	.495	.381
		L	.30	.30	.39		
50	P	H	*.83	.08	.08	.642	.368
		L	.52	.19	.29		
	R	H	*.83	.06	.11	.438	.429
		L	.30	.39	.30		
51	P	H	.04	.29	*.67	.600	.275
		L	.14	.38	.48		
	R	H	.44	.17	*.39	.288	.194
		L	.35	.43	.22		
52	P	H	.13	*.63	.25	.508	.340
		L	.52	.24	.24		
	R	H	.11	*.44	.44	.311	.263
		L	.30	.26	.39		

(* indicates correct answer)

SUMMARY OF REVISIONS MADE ON FORM 2

	Deletions Common to Both	Revisions	Revisions Common to Both P & R
P	3, 18, 25, 42, 48	4, 6, 7, 9, 11, 12, 14, 16, 17, 19, 23, 29, 33, 34, 35, 39, 41, 43, 44, 46, 51	6, 9, 11, 12, 14, 16, 17, 19, 23, 29, 33, 34, 35, 39, 41, 43, 44, 46, 51
R		1, 6, 8, 9, 11, 12, 13, 14, 16, 17, 19, 20, 21, 23, 27, 29, 33, 34, 35, 39, 41, 43, 44, 46, 51, 52	

SUMMARY OF ARITHMETIC MEANS OF FORM 2

School	Class	Pictorial	Reading
A	1	28.4	24.7
	2	29.1	24.4
B	1 (high average class)	28.9	27.5
	2 (average class)	23.6	23.3
	3 (low average class)	27.0	21
Very low average readers from class 3		26.7	20.3
C	1	27.4	22.7
	2	27.9	25.1
	3	25.2	22.2
	4	24.7	24.7
Overall Test Means		26.9	23.8

APPENDIX C

(Note: Correct answers are indicated by an asterisk [*])

PICTORIAL SCIENCE TEST

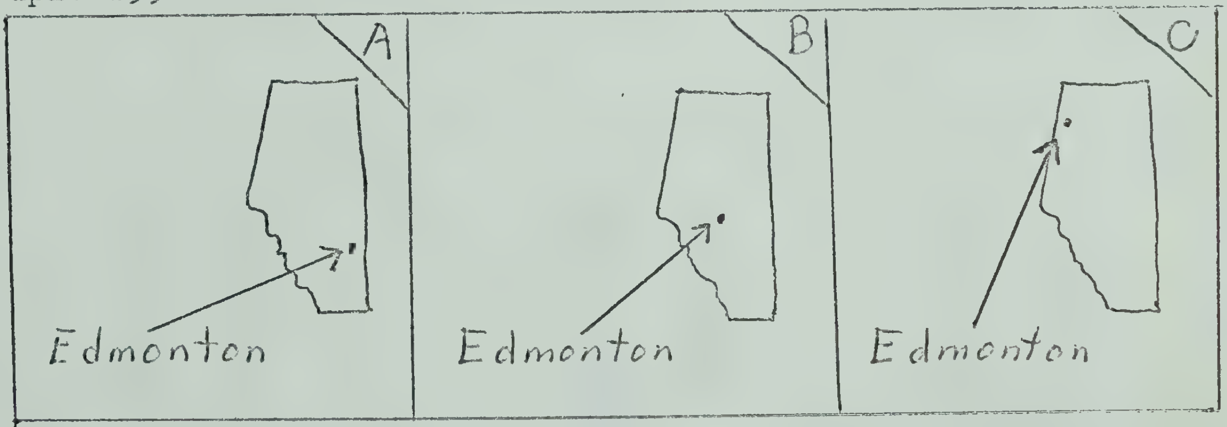
SECTION ONE

Do not write in any way on the pages of this booklet. Place your answers on the separate answer sheet.

In each of the following 19 questions you will be given a problem to solve. It will involve a scientific concept. Only one of the possibilities, A, B, or C is the correct solution. On the answer sheet you will see A 1 B 2 C 3 D 4 E 5 Only spaces A, B, or C should ever be marked. Do not put any marks in spaces D or E. If you wish to change an answer, you must erase it completely. Then clearly mark the answer you prefer. Start on # 1.

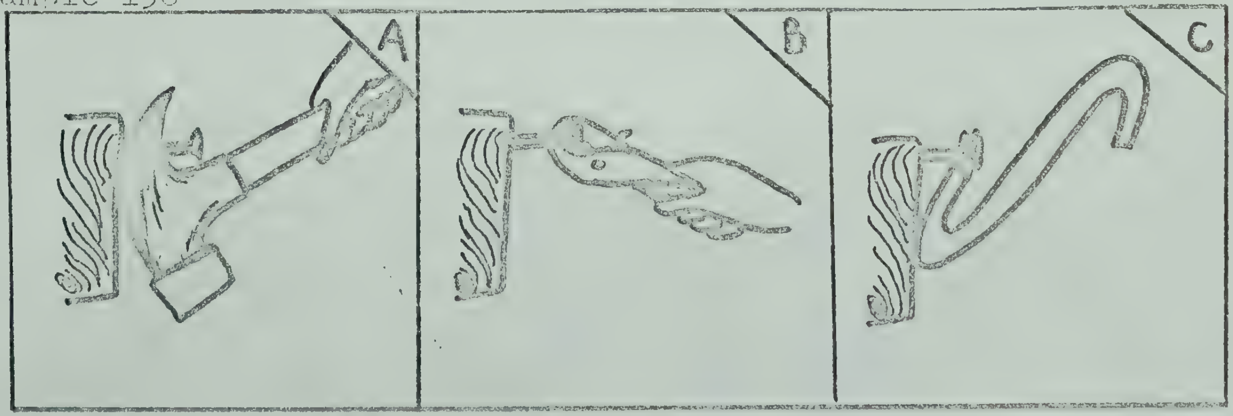
Here are two sample questions;

Example 135



Beside # 135, you should have marked B like this B 2

Example 136



Which answer did you choose?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

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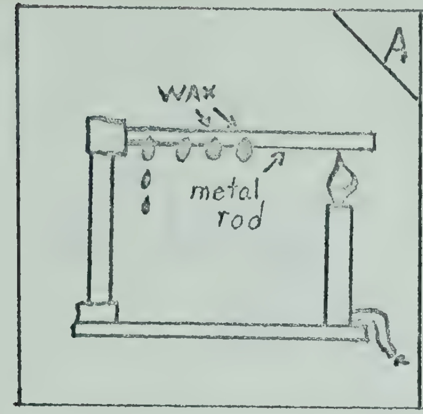

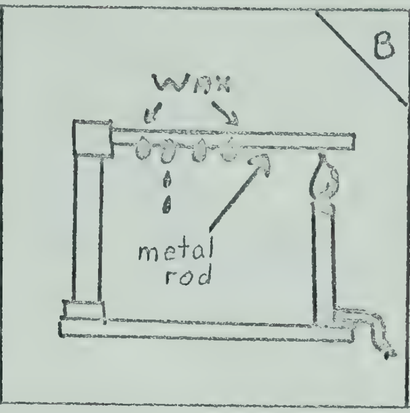

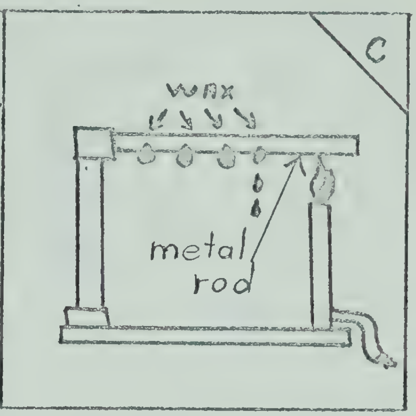

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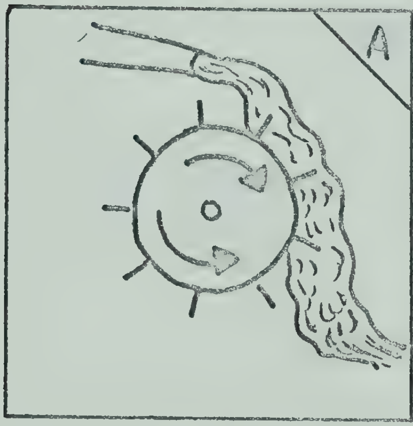

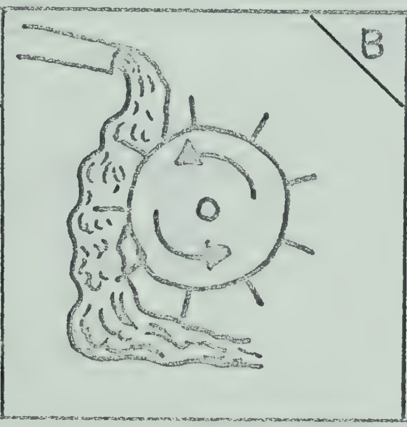

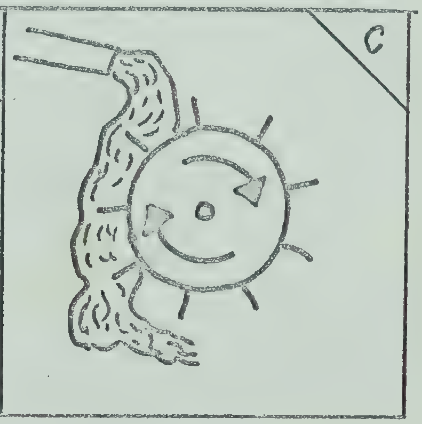

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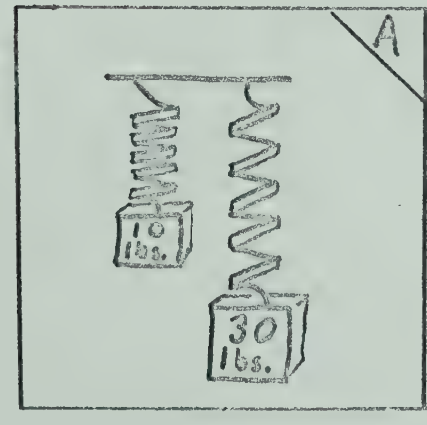

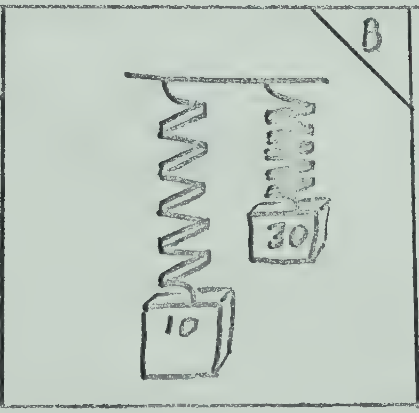

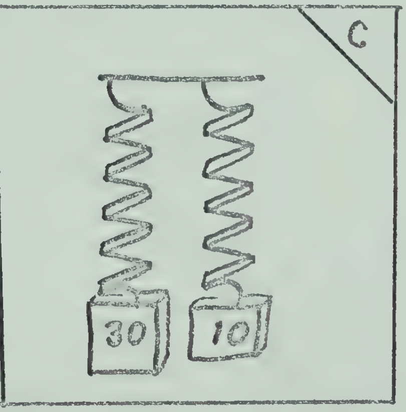

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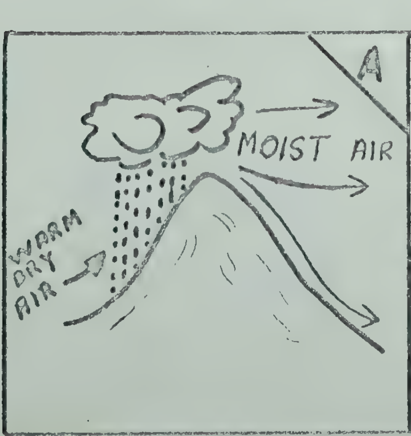

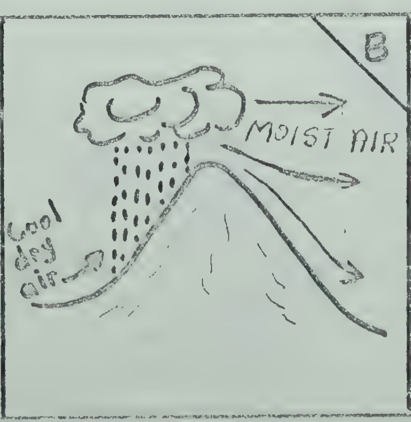

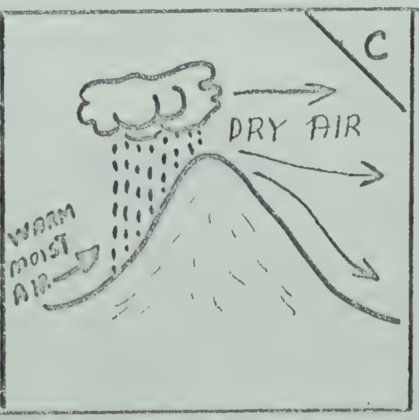

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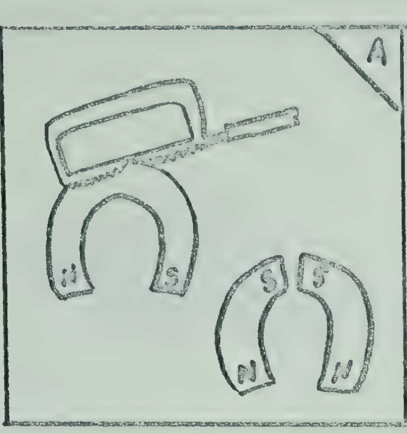

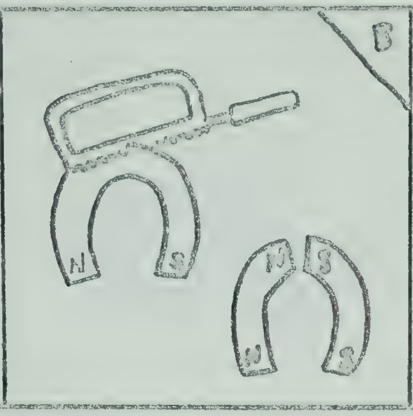

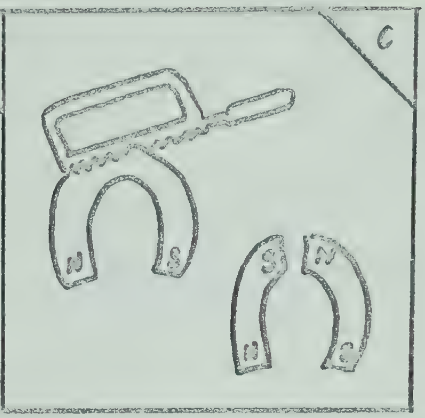

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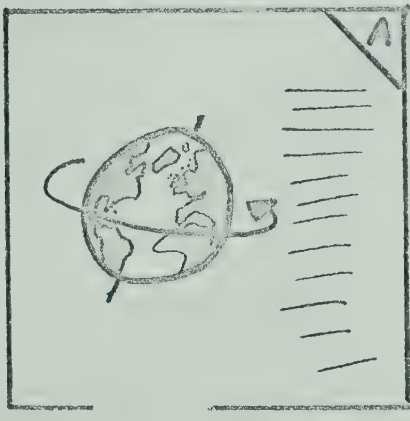

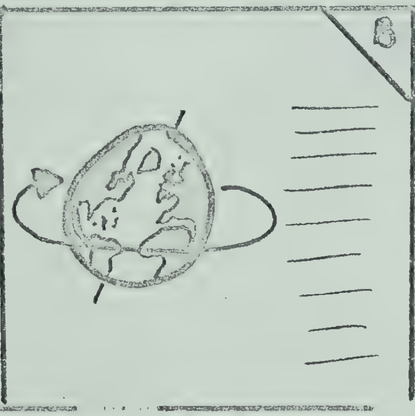

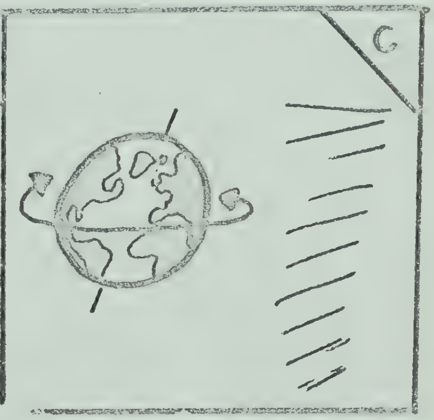

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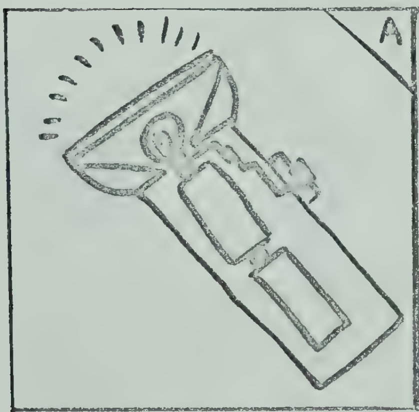

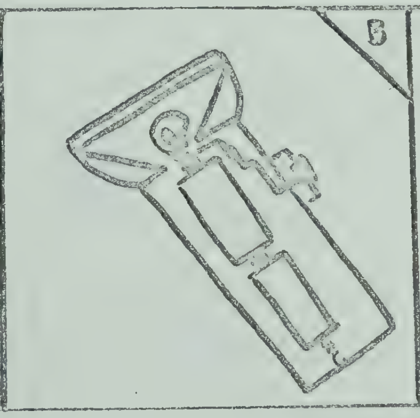

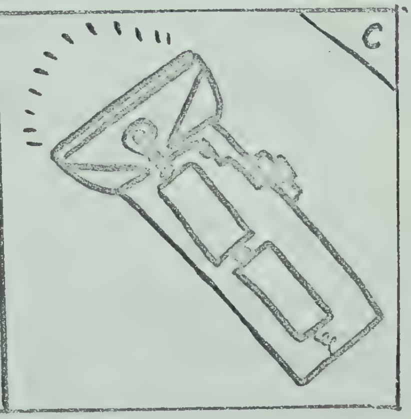

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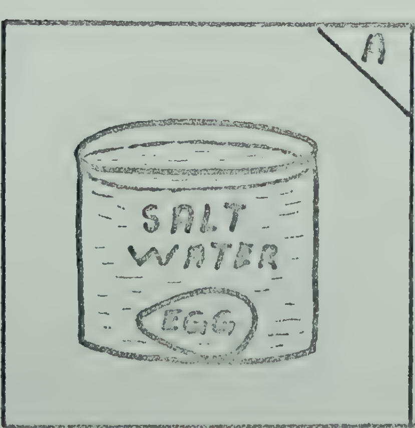

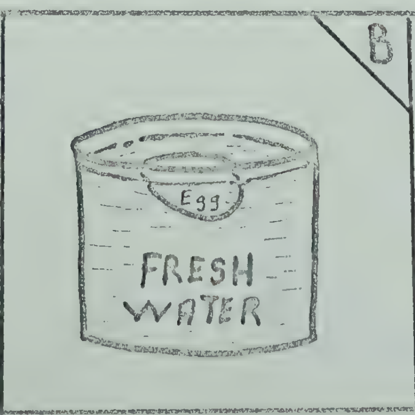

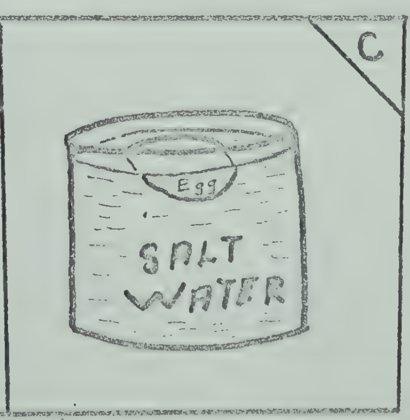

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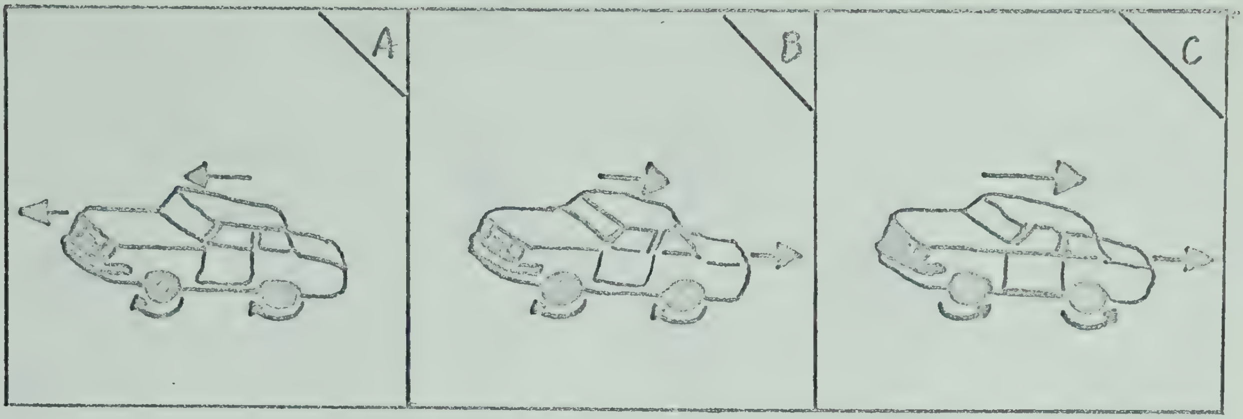

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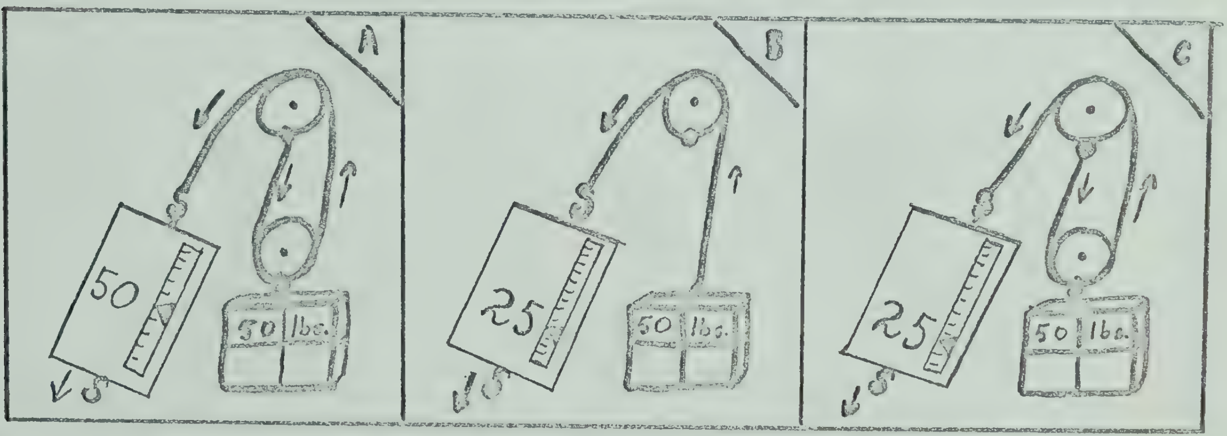

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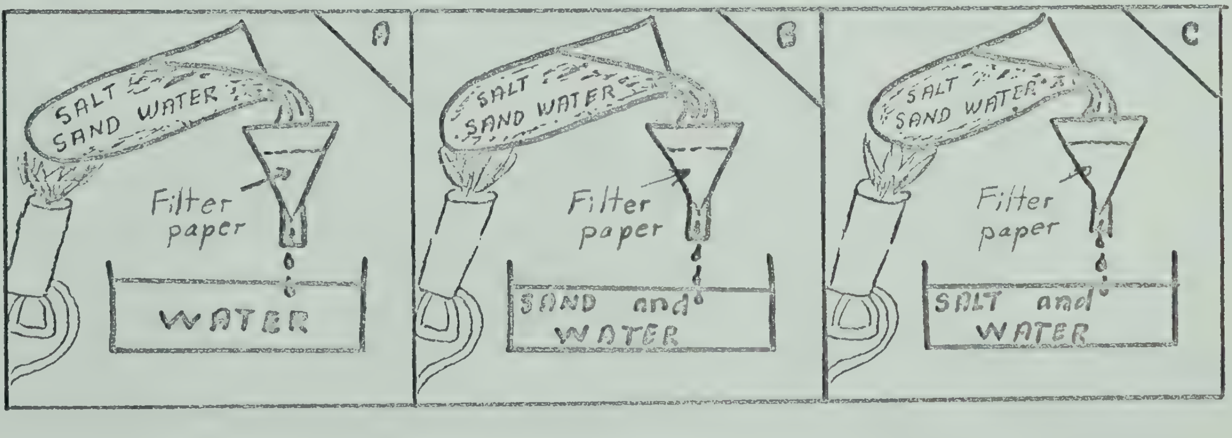

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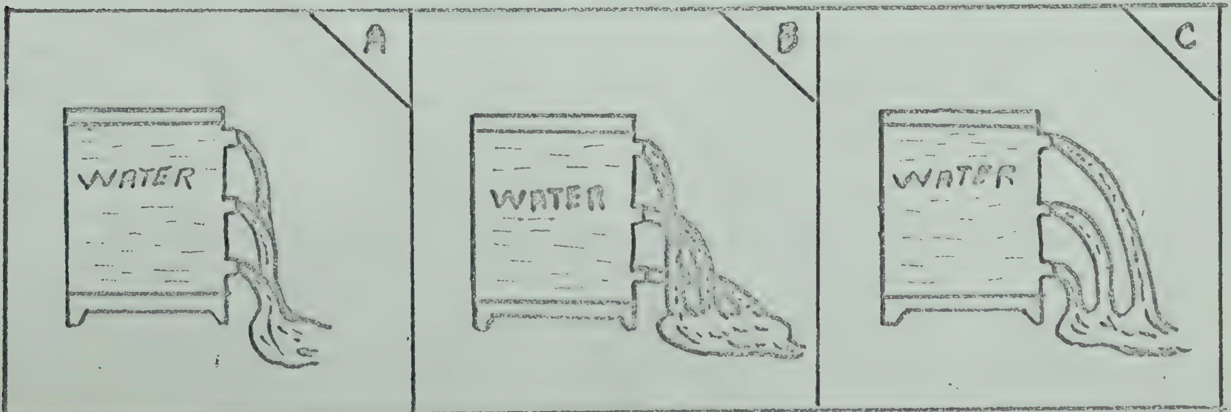

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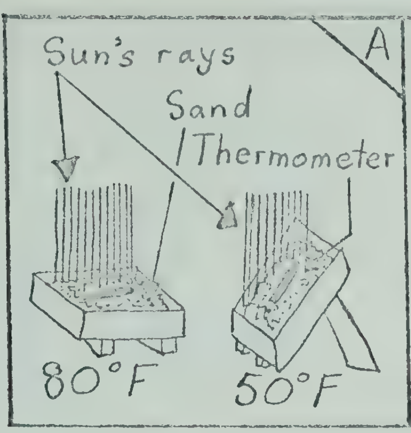

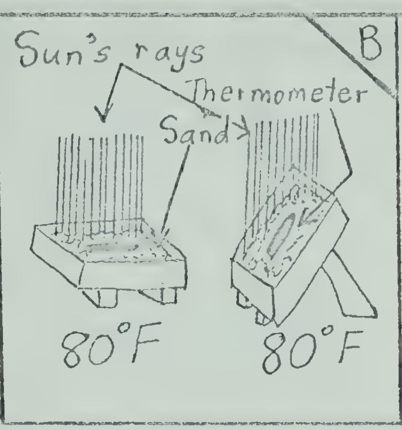

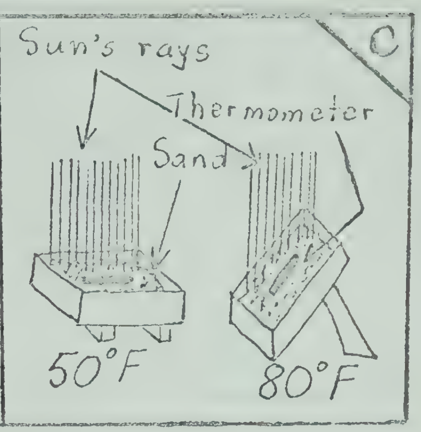

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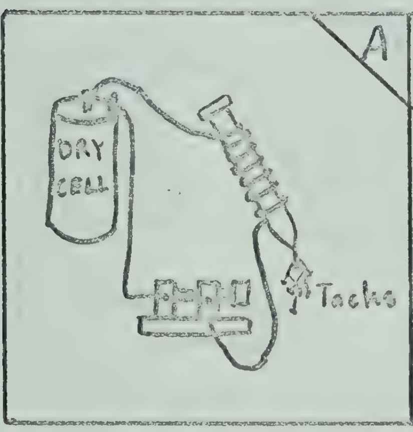

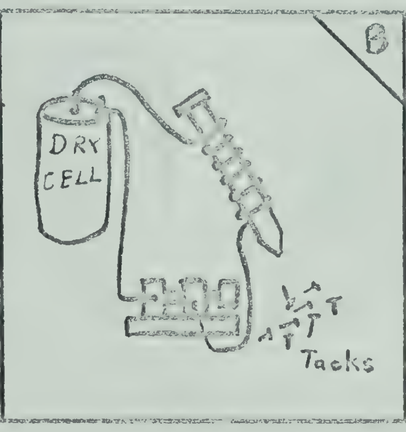

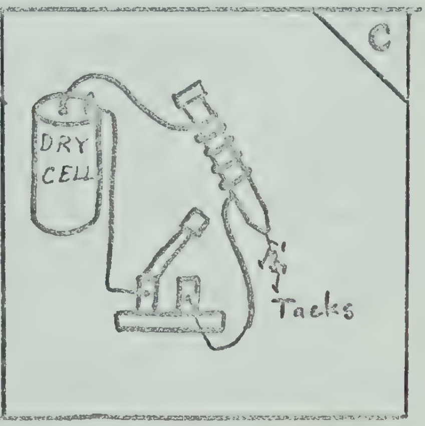

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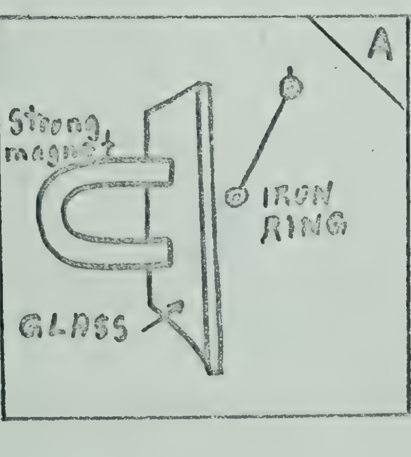

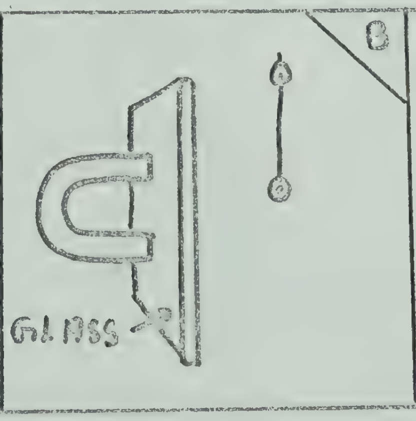

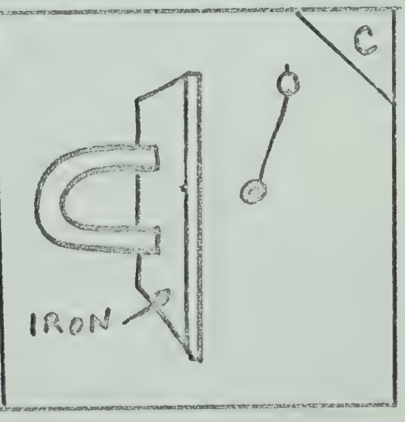

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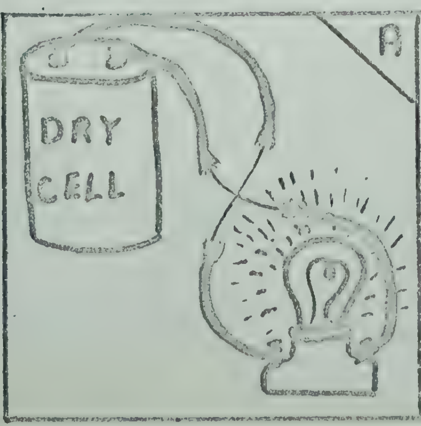

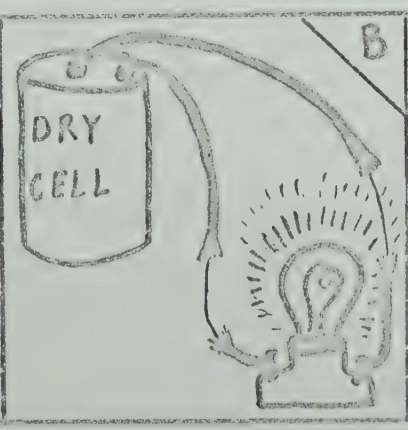

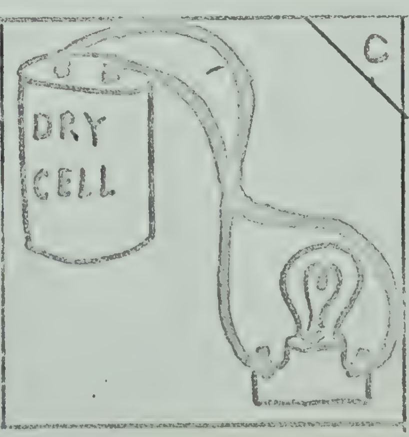

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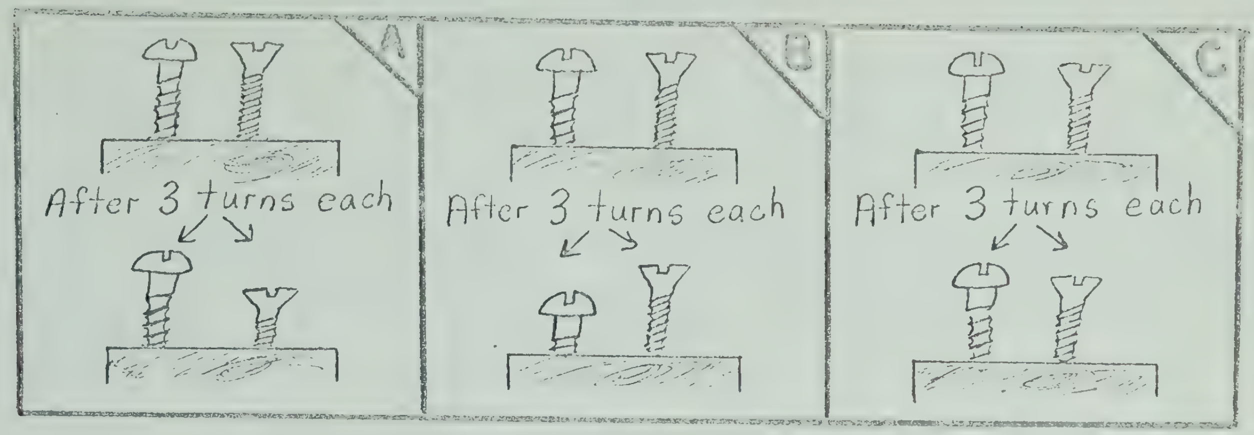

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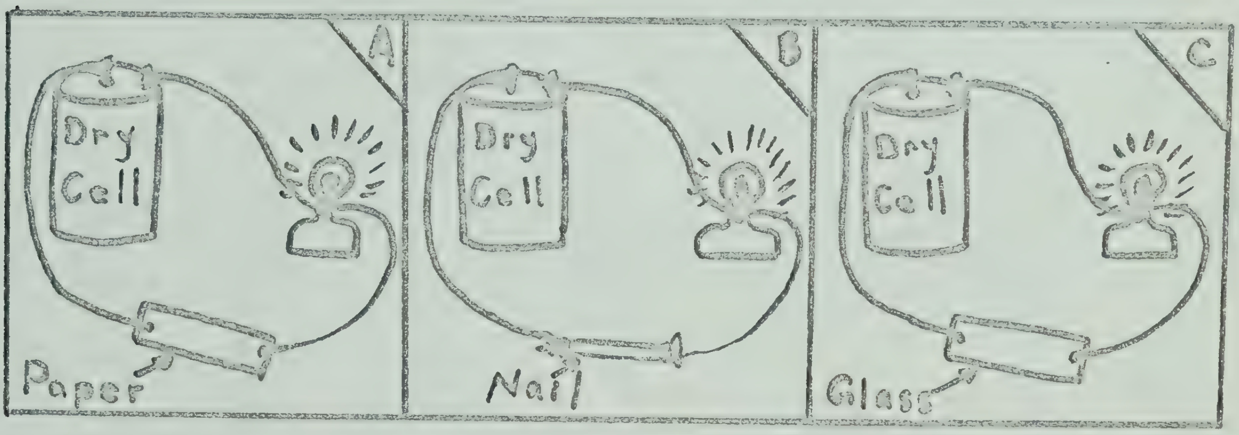

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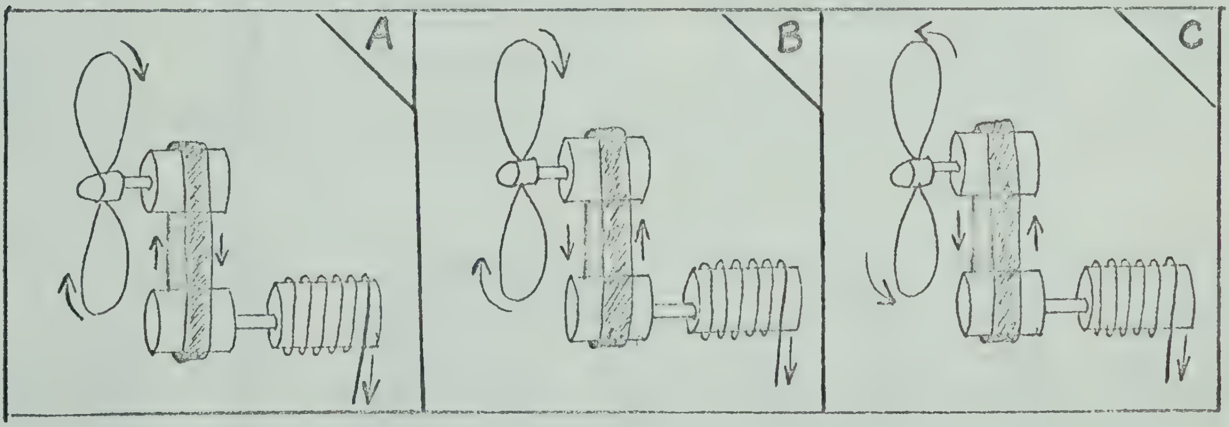

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PICTORIAL SCIENCE TEST

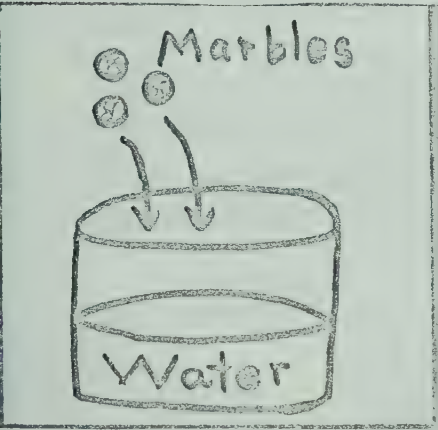
SECTION TWO

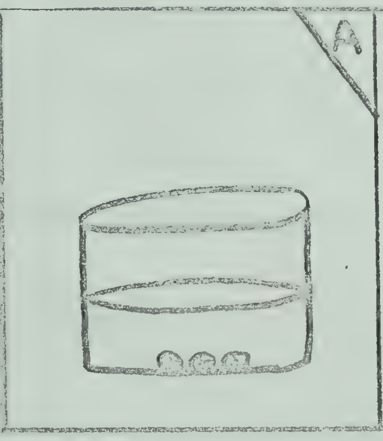
Continue through the following 13 questions in the same way you did those in SECTION ONE. Place your answers on the answer sheet, starting with number 20.

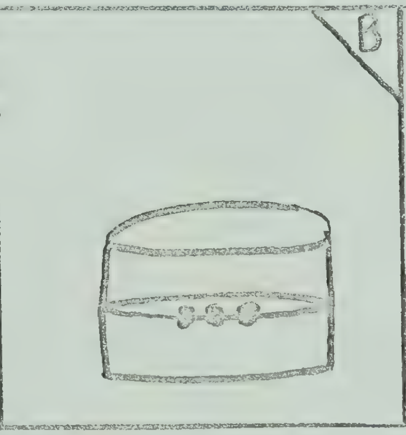
In each of the following questions, the first picture will show something happening or about to happen. Pictures A, B, or C will show the possible results.

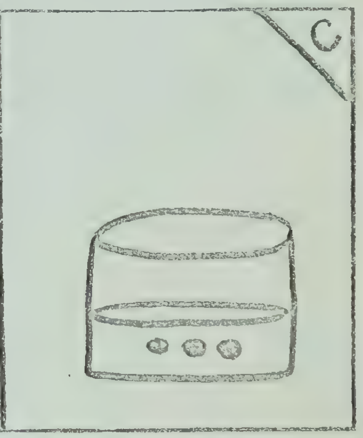
Here are two sample questions,

Example 137



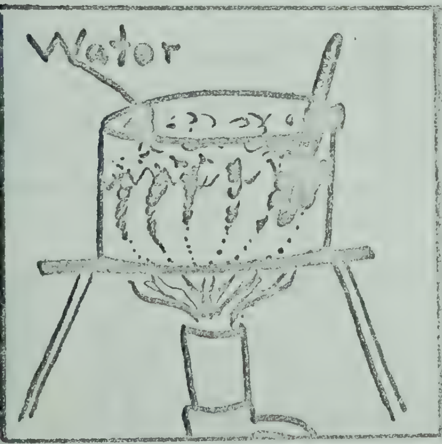


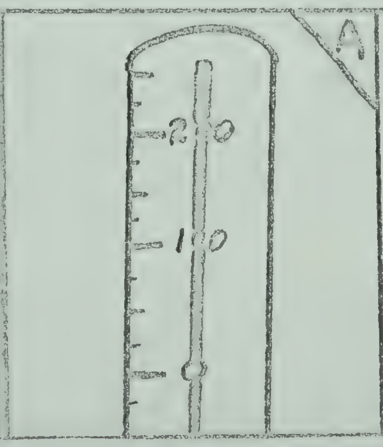


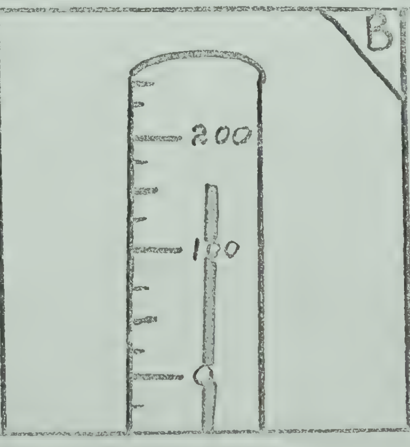


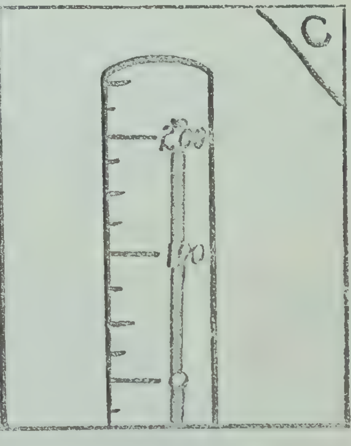
Beside #137 you should have marked A like this A 1

Example 138









Place your answer on the answer sheet. Which answer did you choose?

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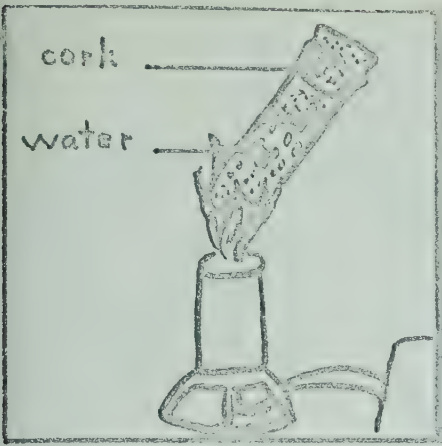

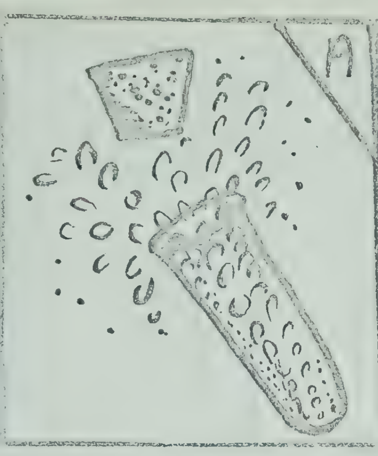

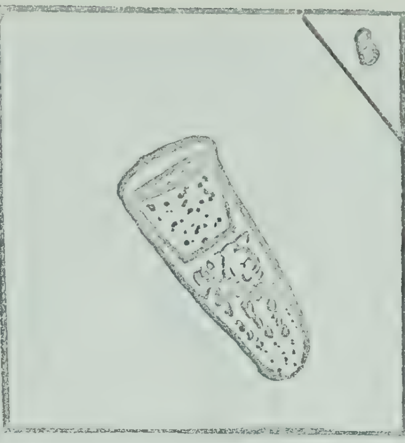

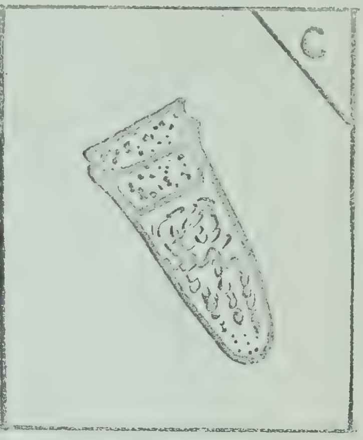

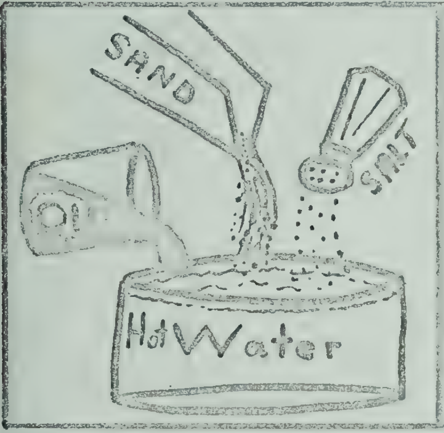

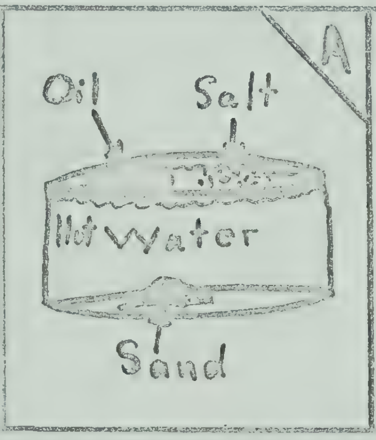

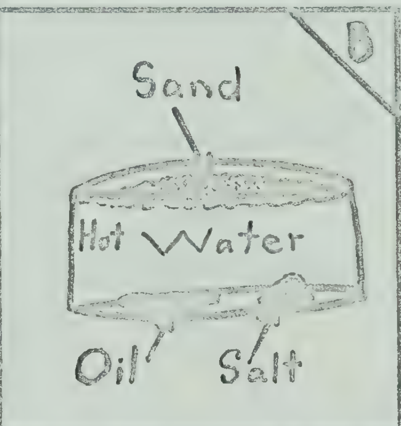

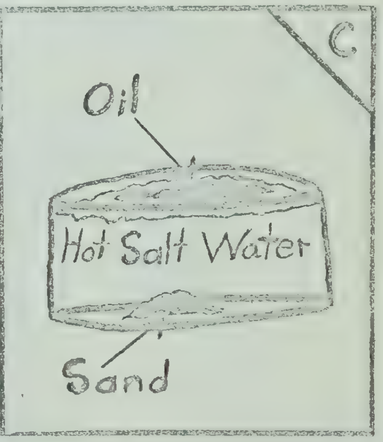

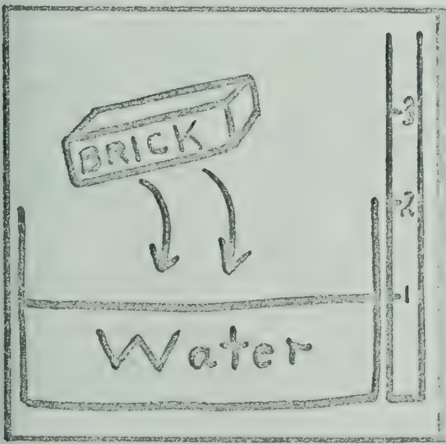

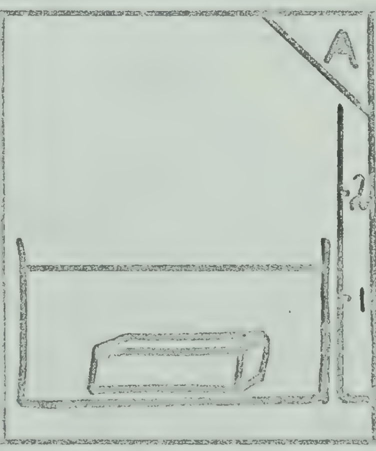

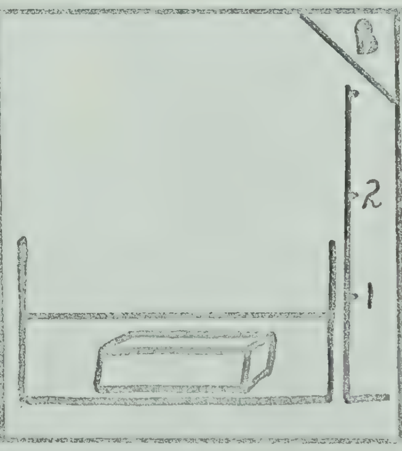

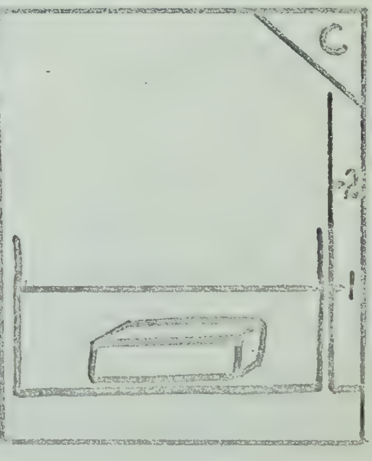

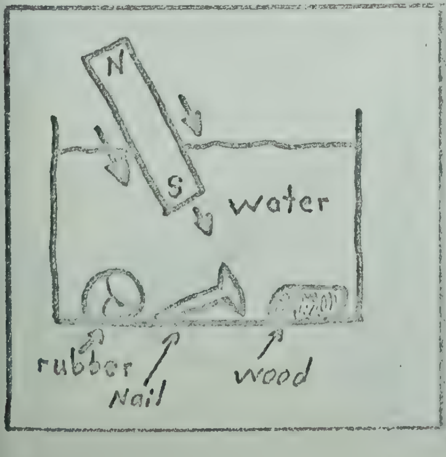

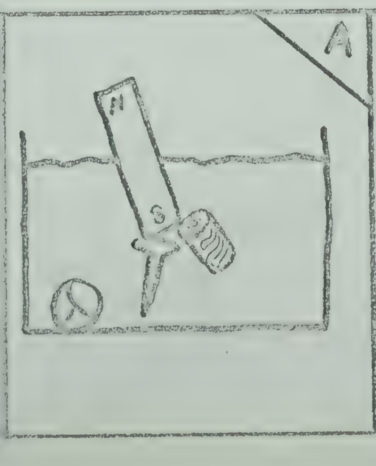

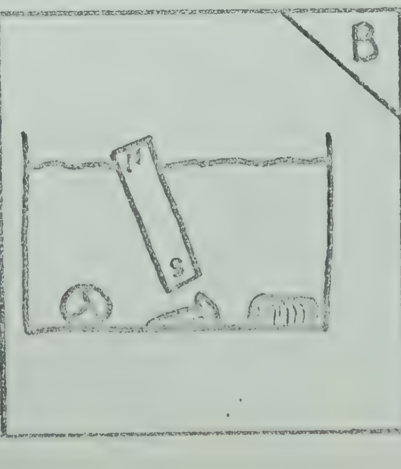

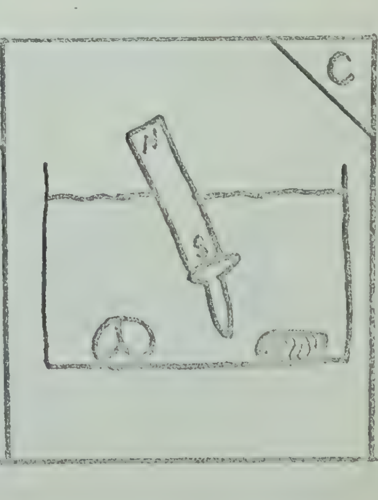

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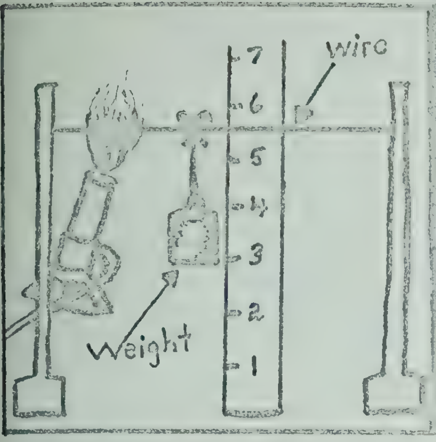

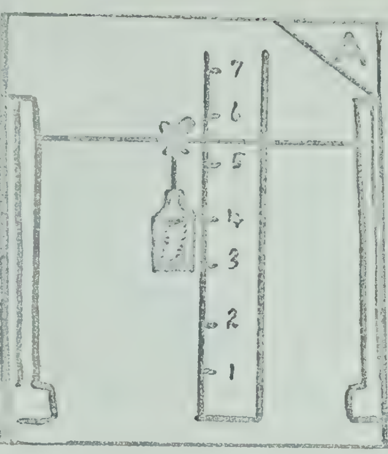

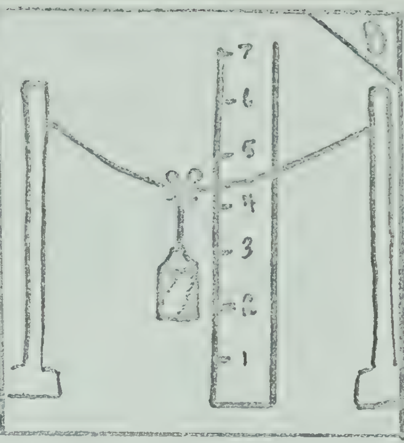

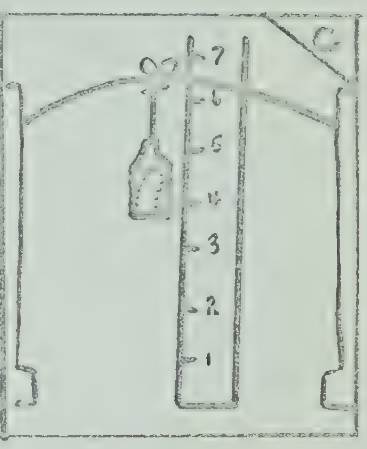

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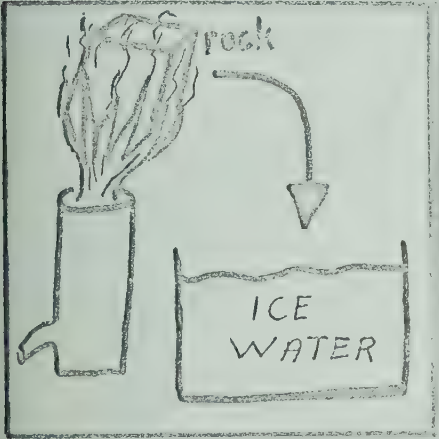

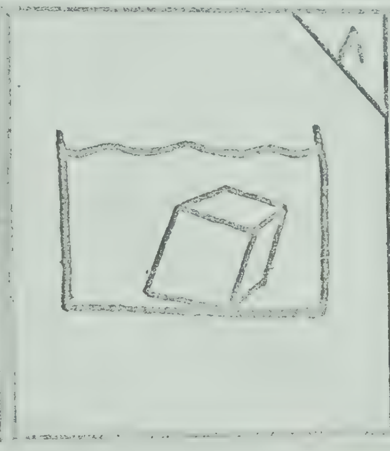

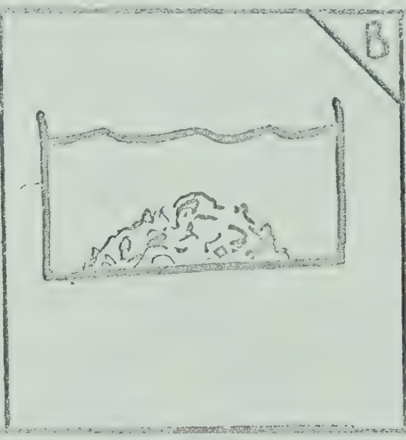

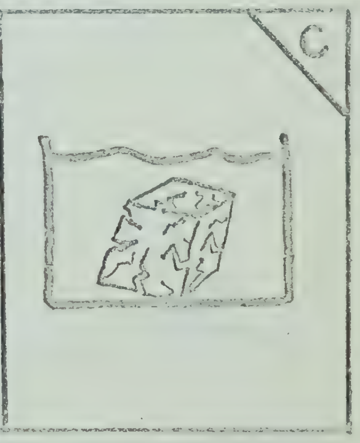

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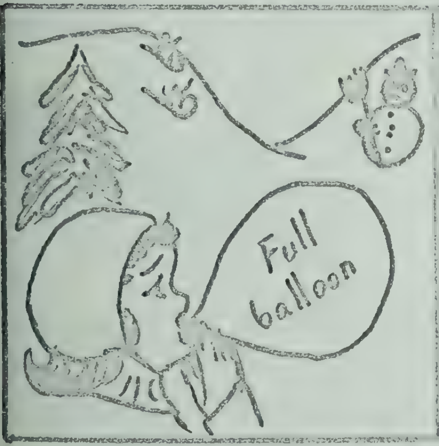

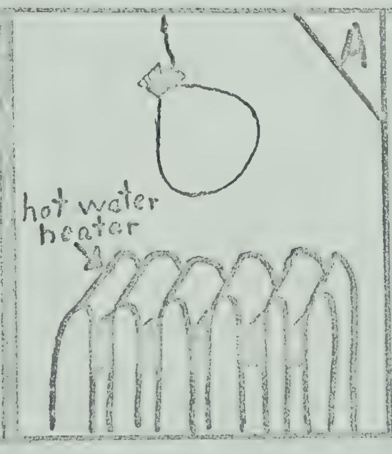

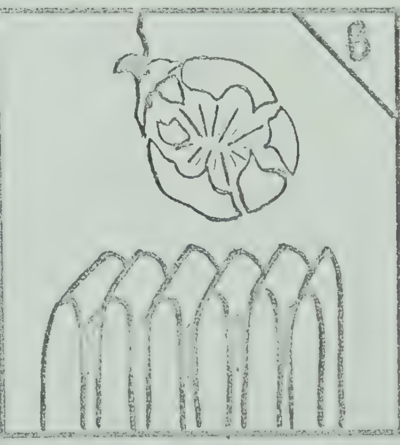

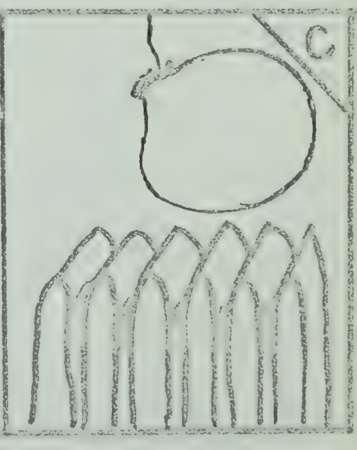

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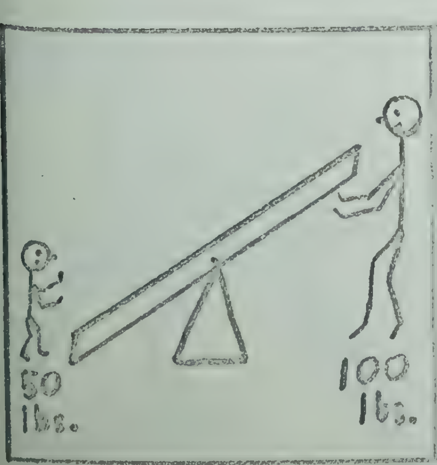
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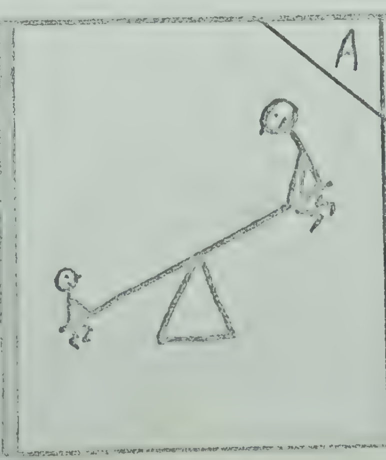

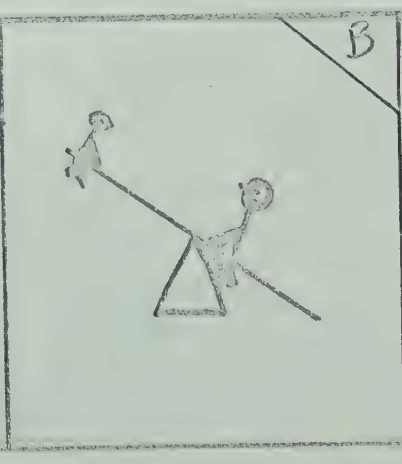

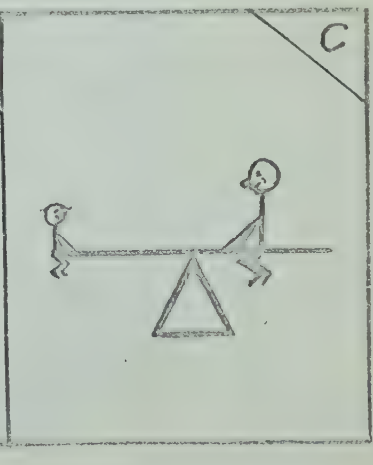

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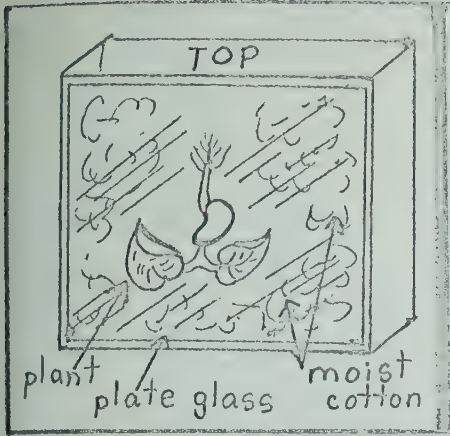

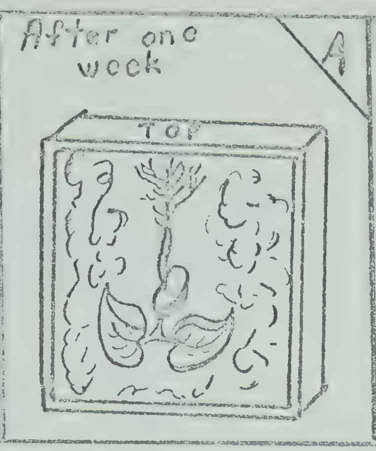

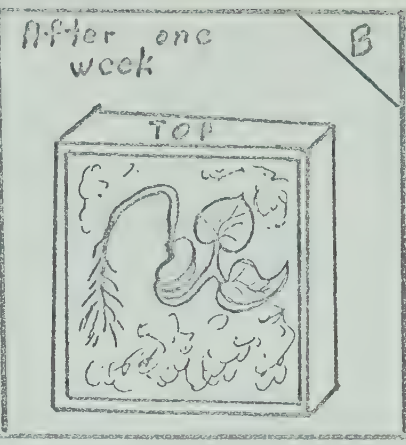

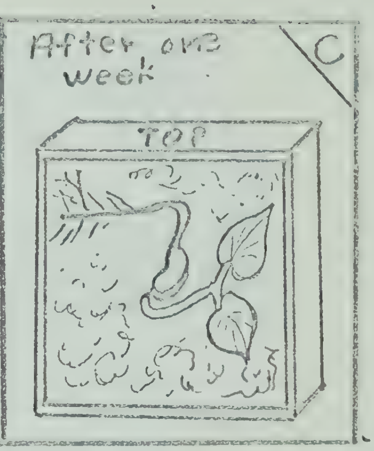

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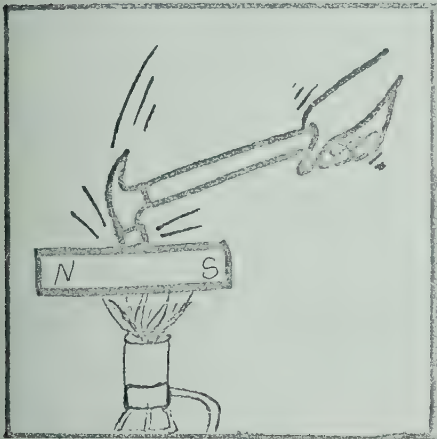

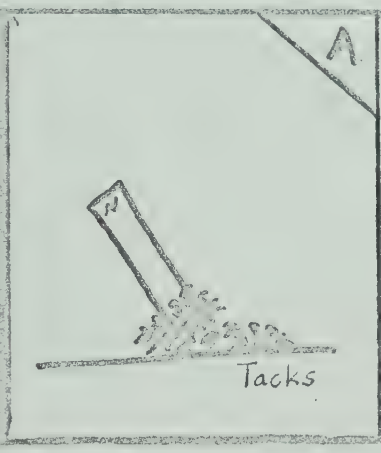

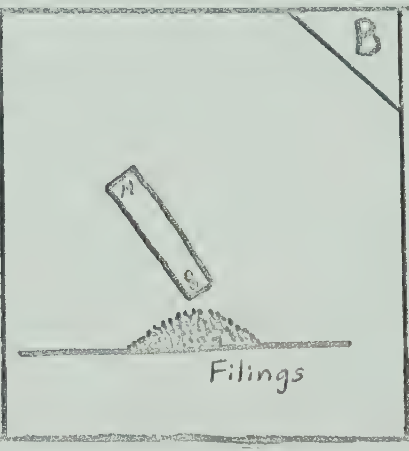

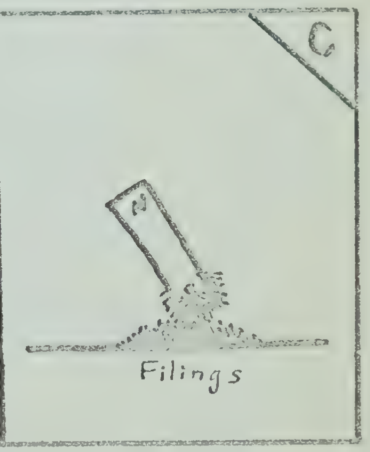

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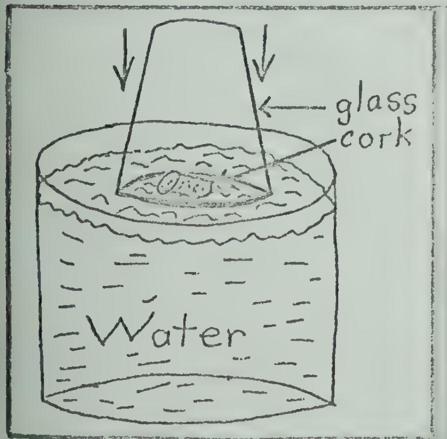

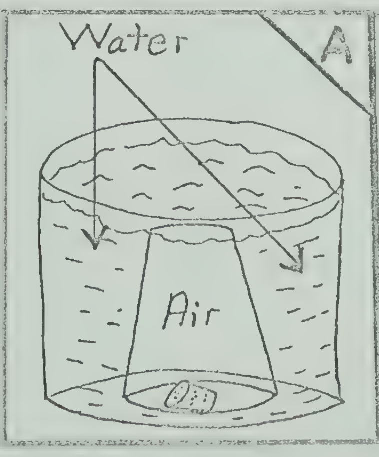

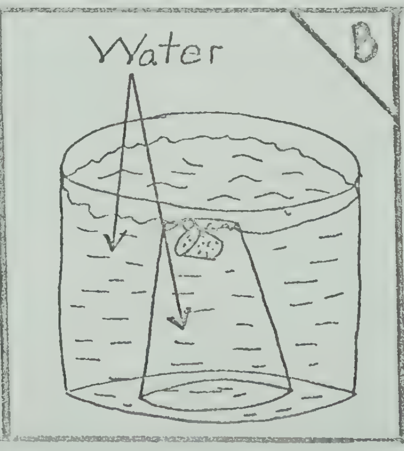

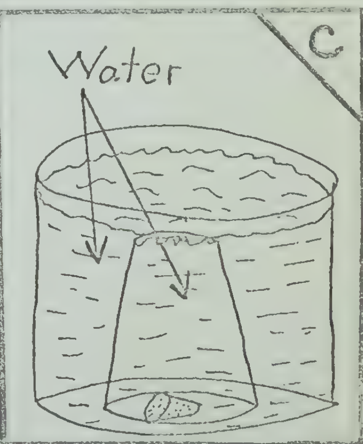

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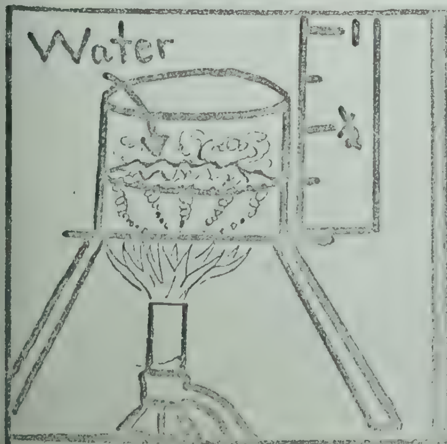

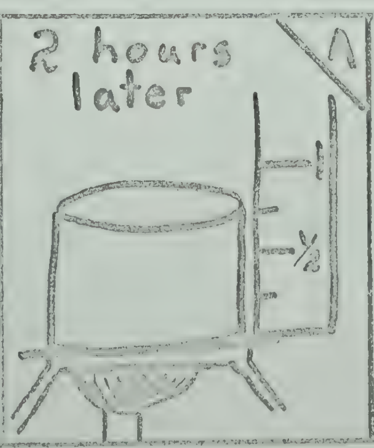

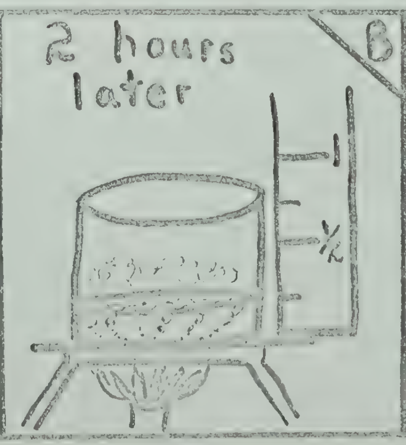

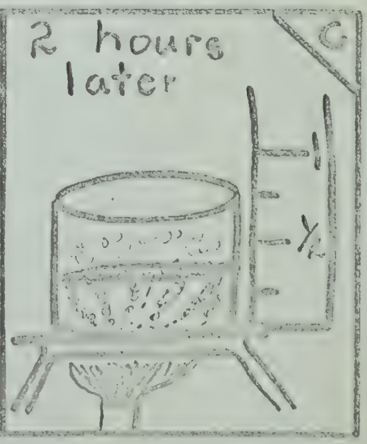

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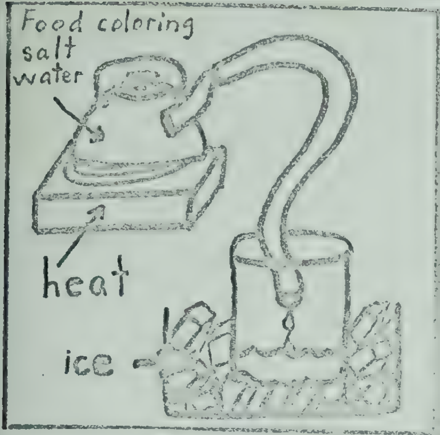

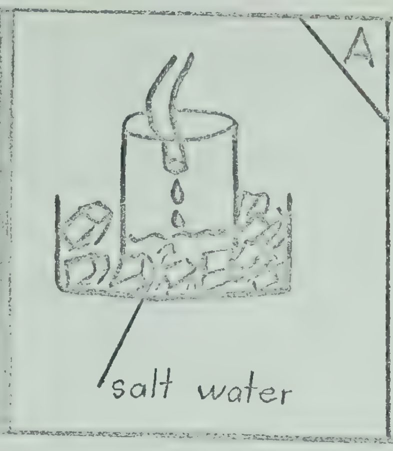

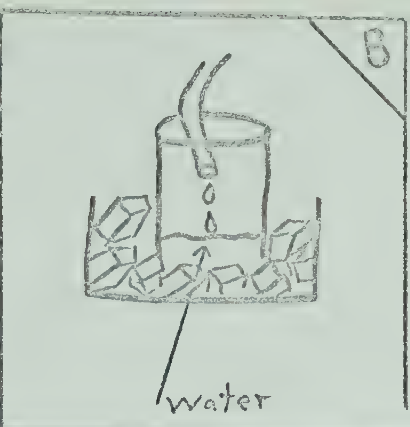

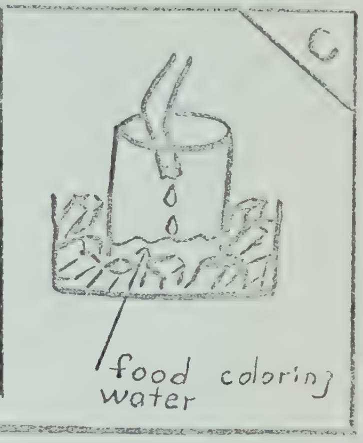

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PICTORIAL SCIENCE TEST

SECTION THREE

Do not write in any way upon the pages of this booklet. Place your answers on the answer sheet in the same way you did in SECTIONS ONE and TWO. Start on number 33.

In each of the following 15 questions you will find three things at the top which are alike in one main way. At the bottom of the question are three other things (A, B, C). Only one of A, B, or C could be put with the group at the top and belongs with them. You are to discover the rule by which the top ones are grouped and then choose one of A, B, or C.

Two sample questions are on the following page.

Example 139

B 2 is the answer because the group members and the walnut are all parts of plants that we eat.

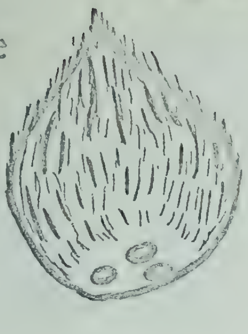
Example 140

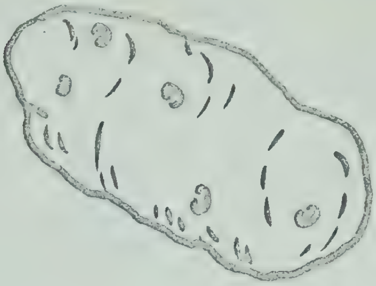
Which answer did you mark on your answer sheet?

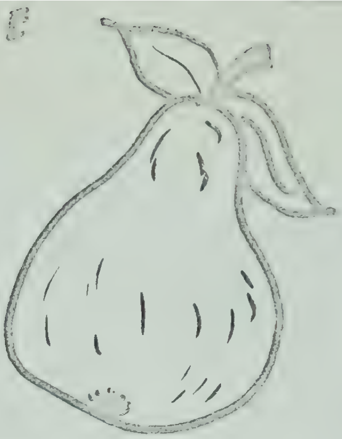
DO NOT TURN THE SAMPLE PAGE UNTIL YOU ARE TOLD TO DO SO

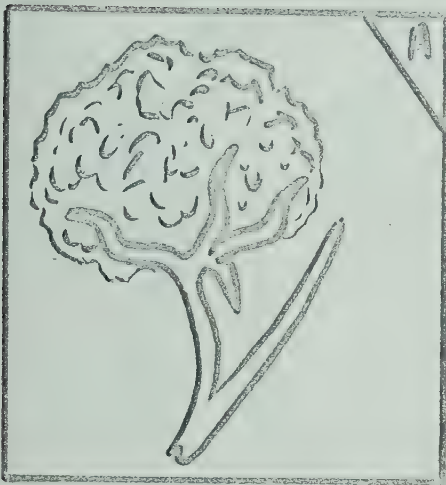
DO NOT MARK THIS PAGE

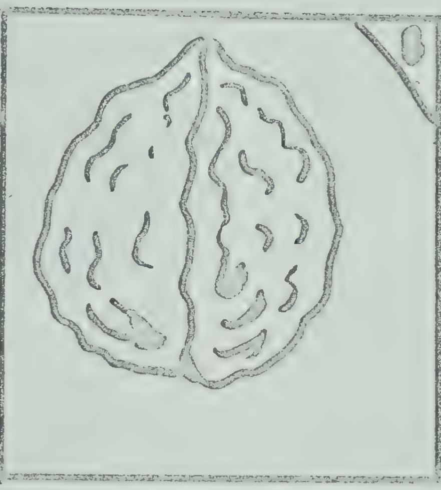
Example 139

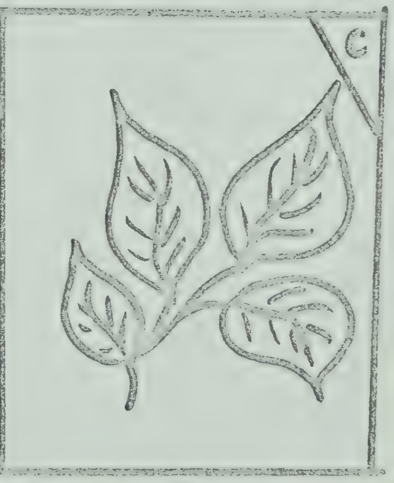












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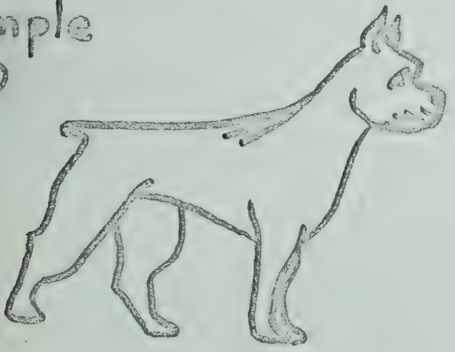

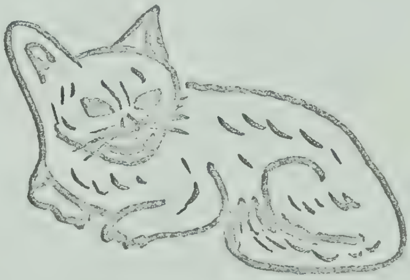

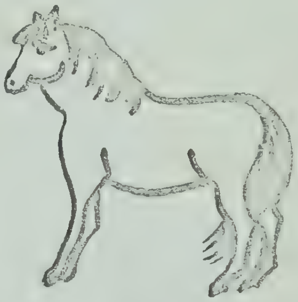

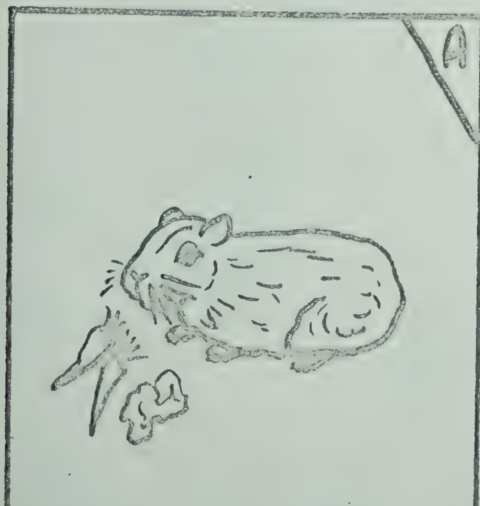

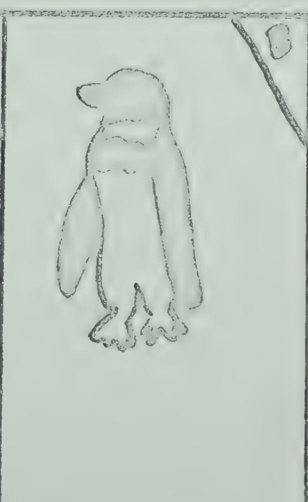

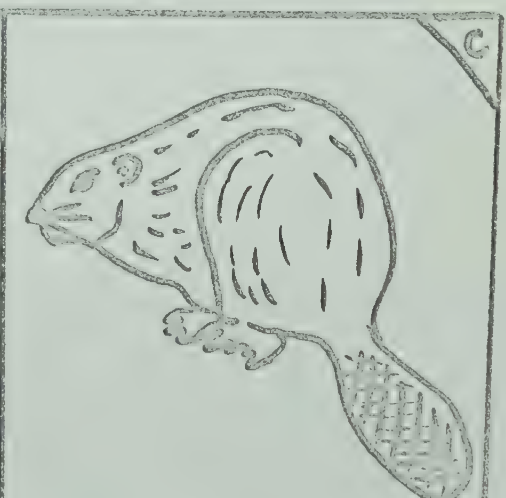

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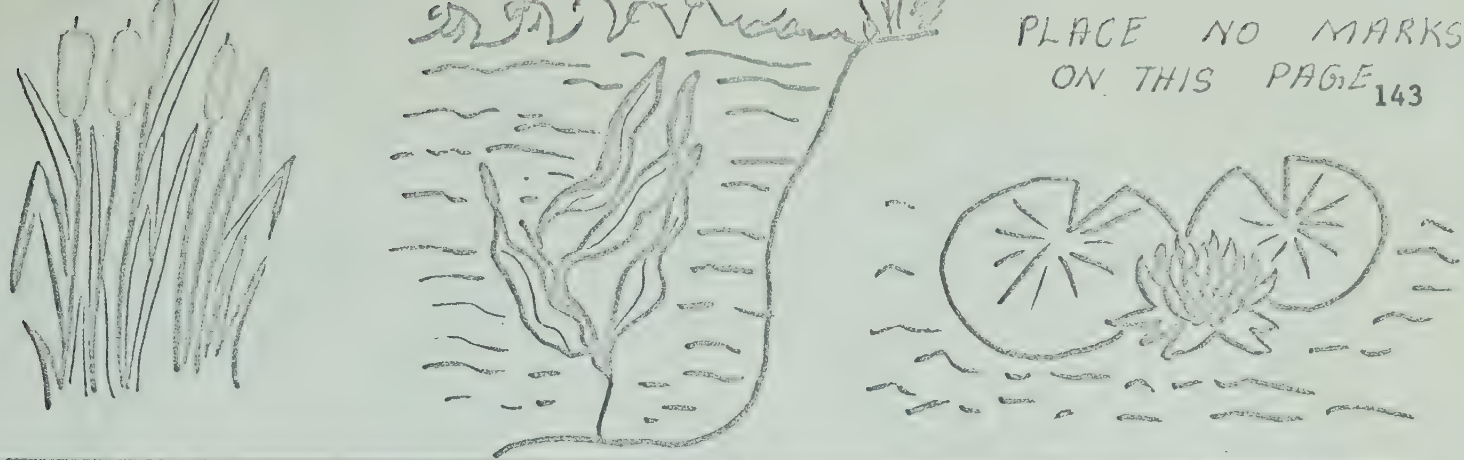

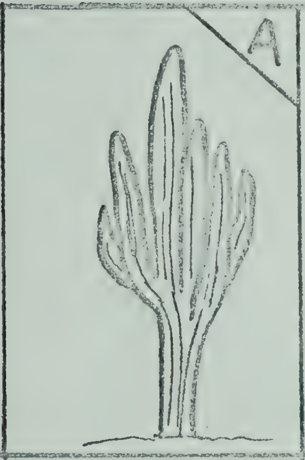

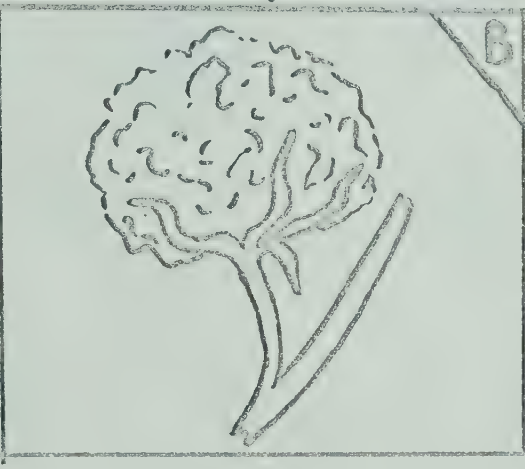

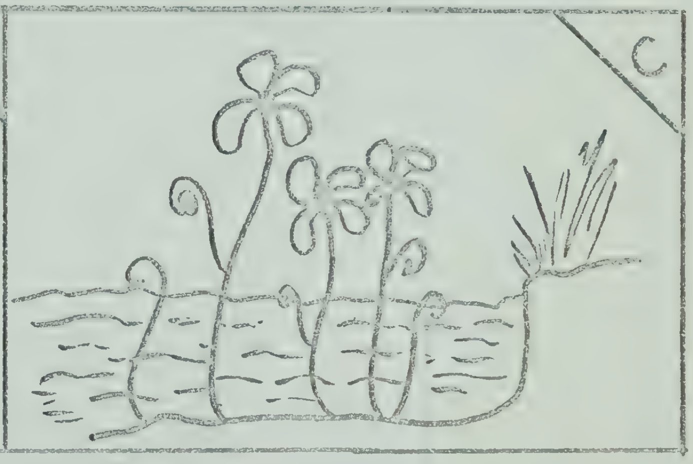

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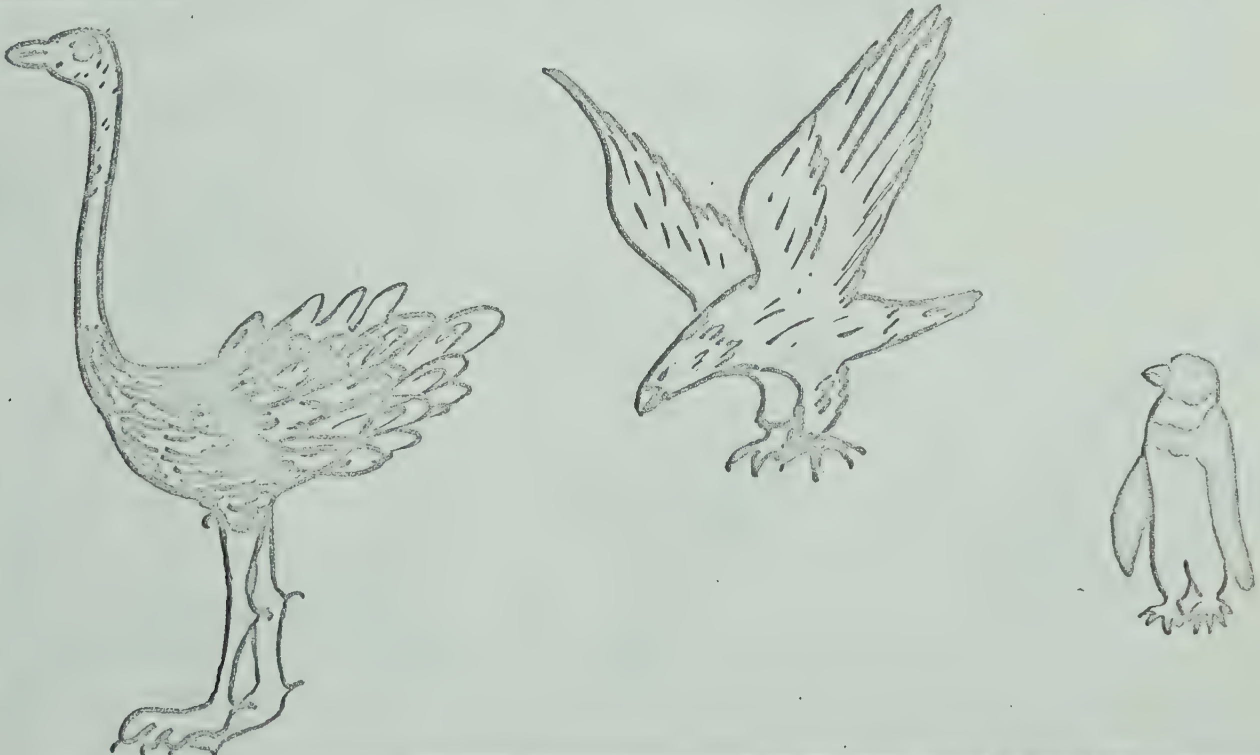

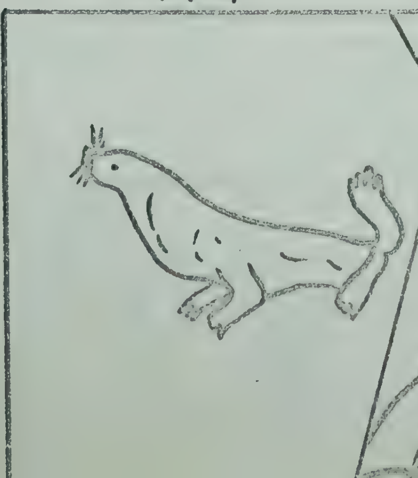

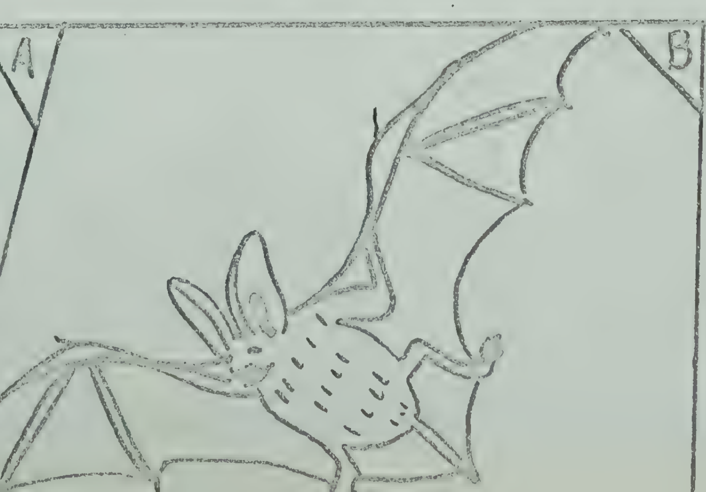

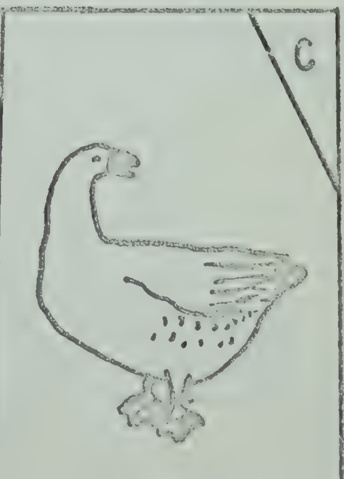

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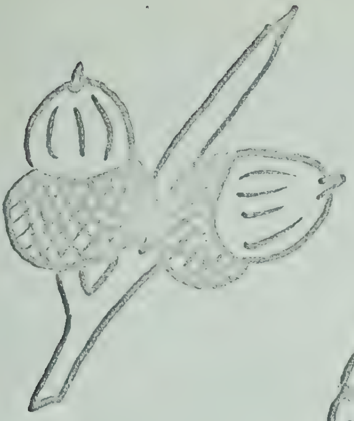
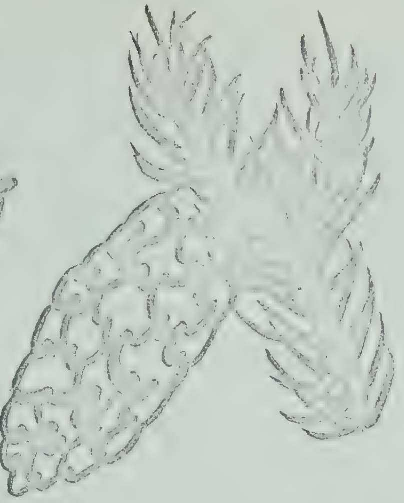
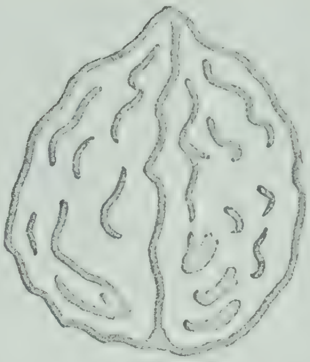

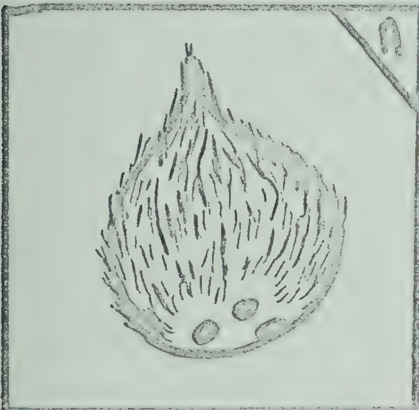

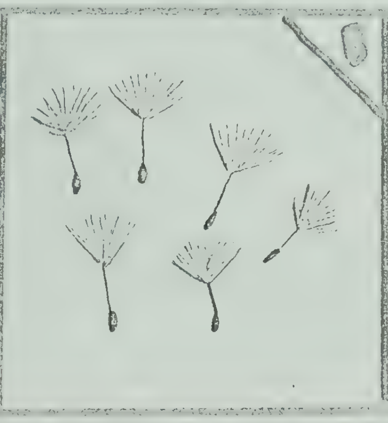

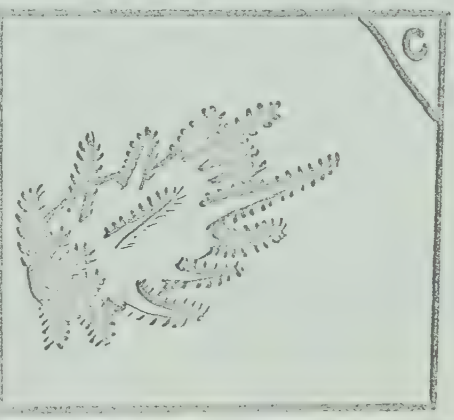

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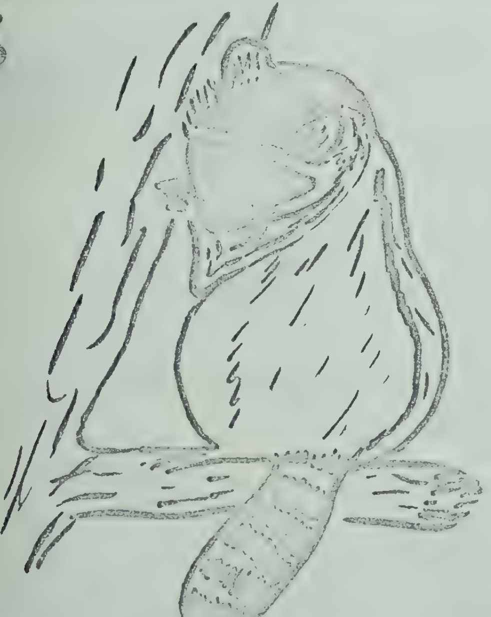
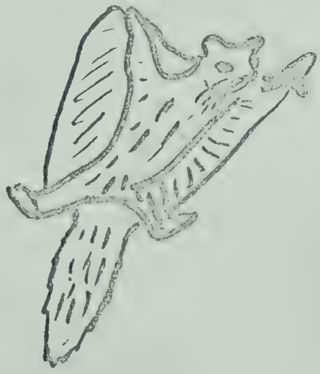
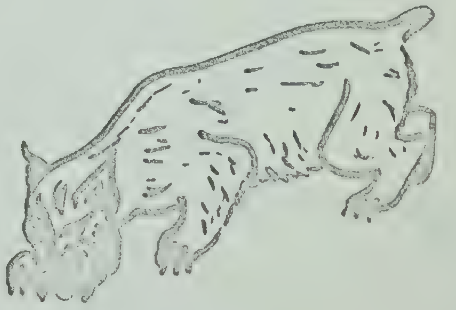

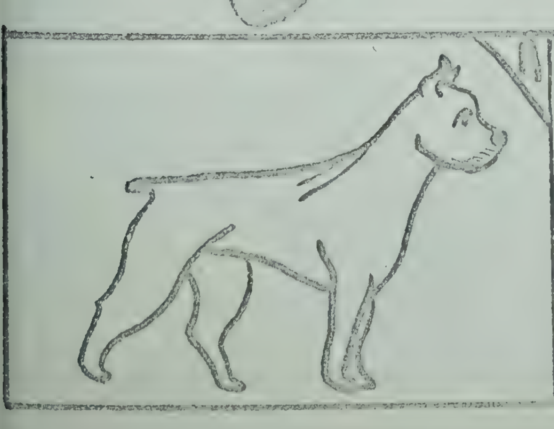

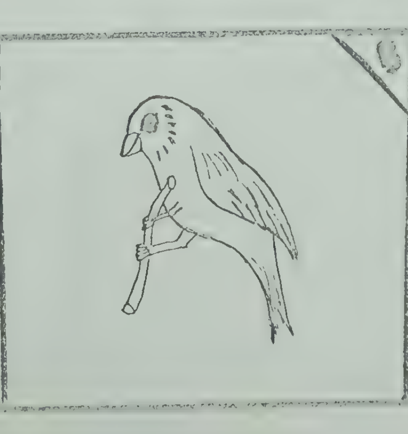

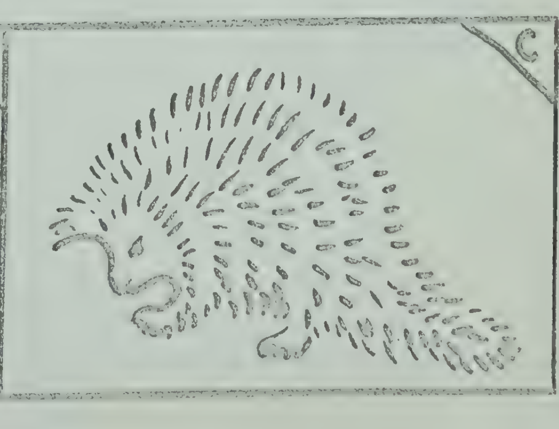

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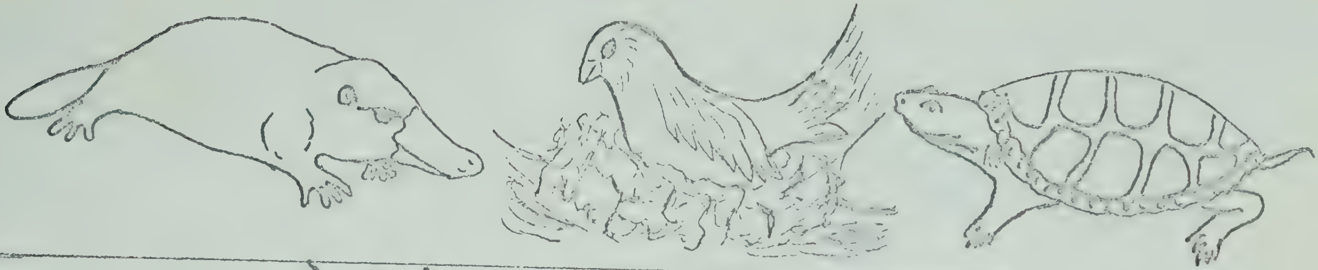

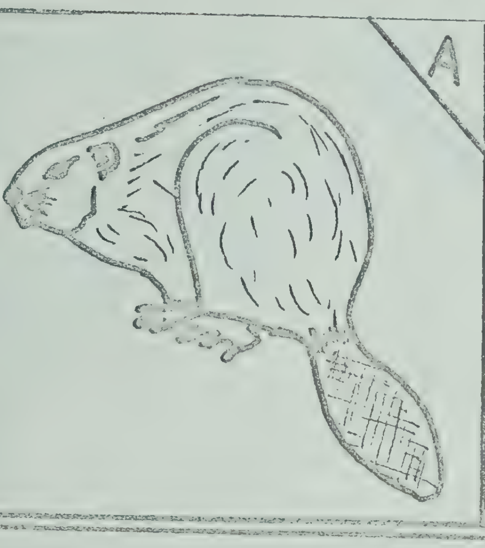

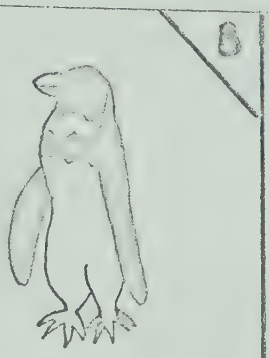

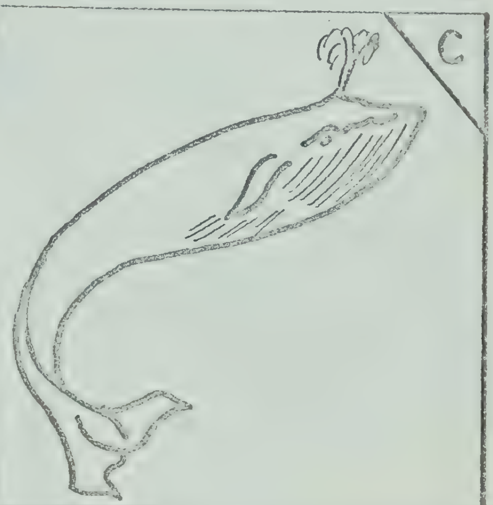

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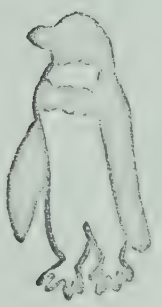

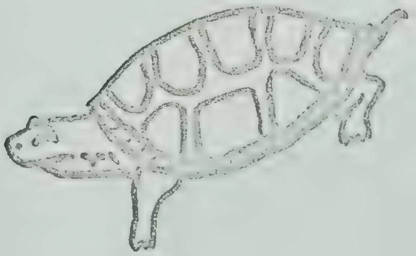

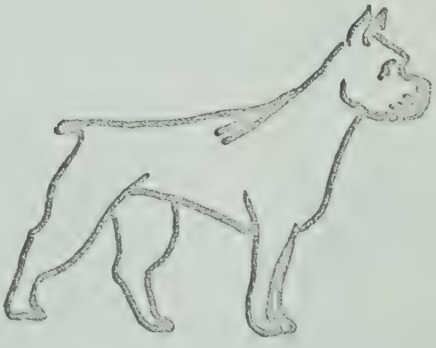

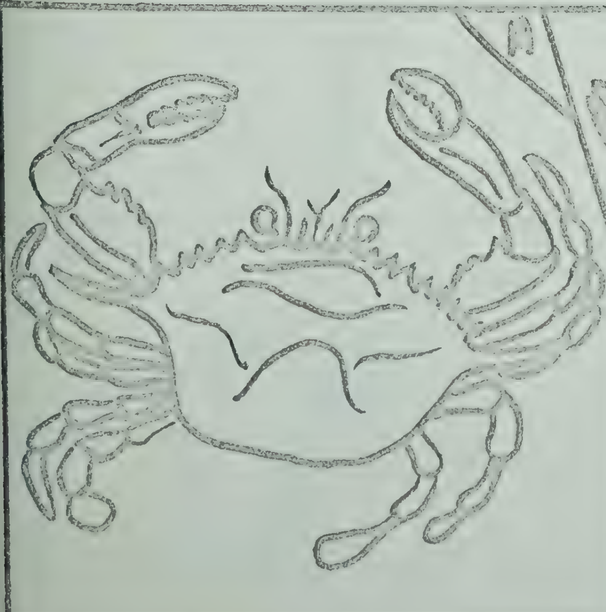

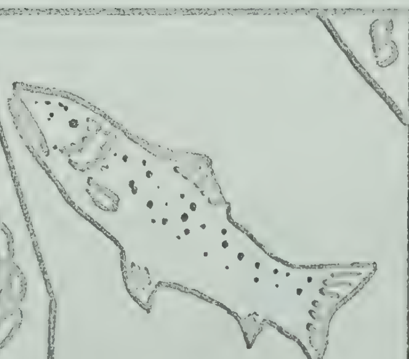

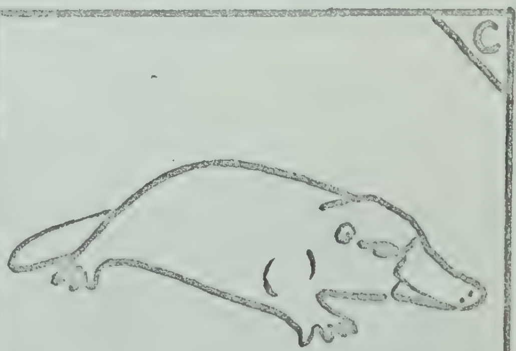

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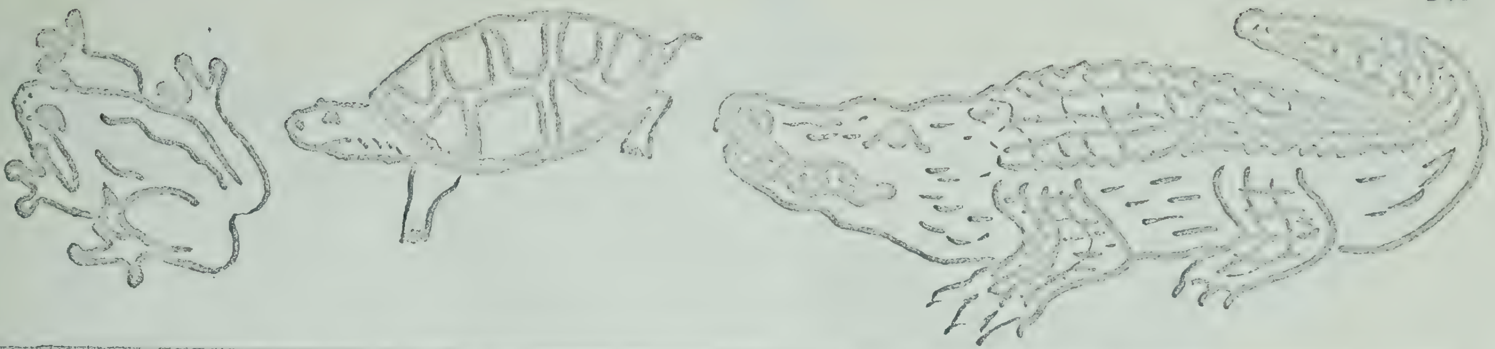

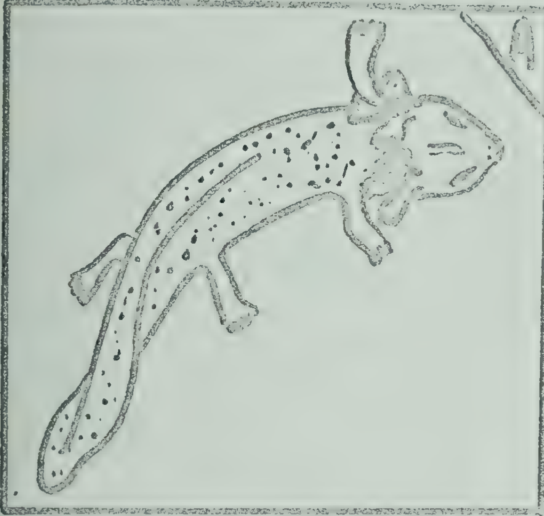

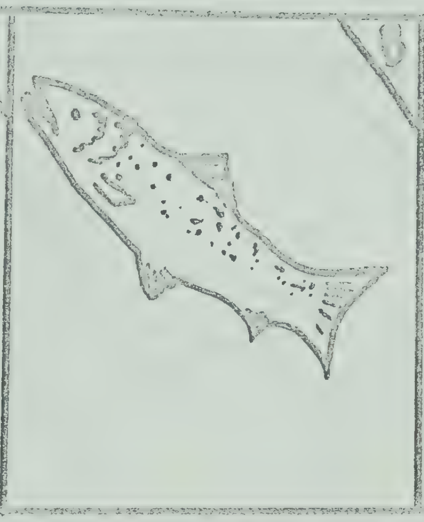

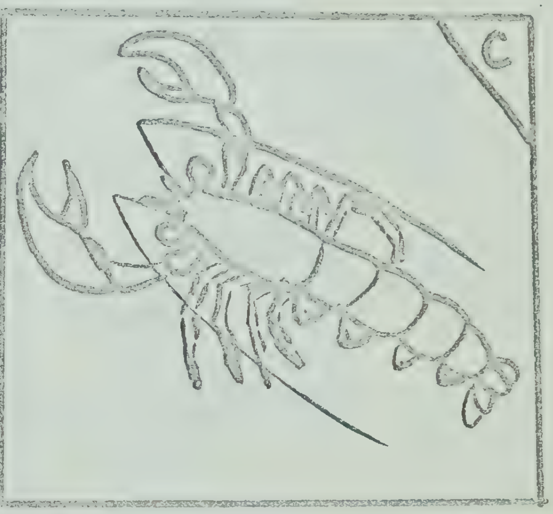

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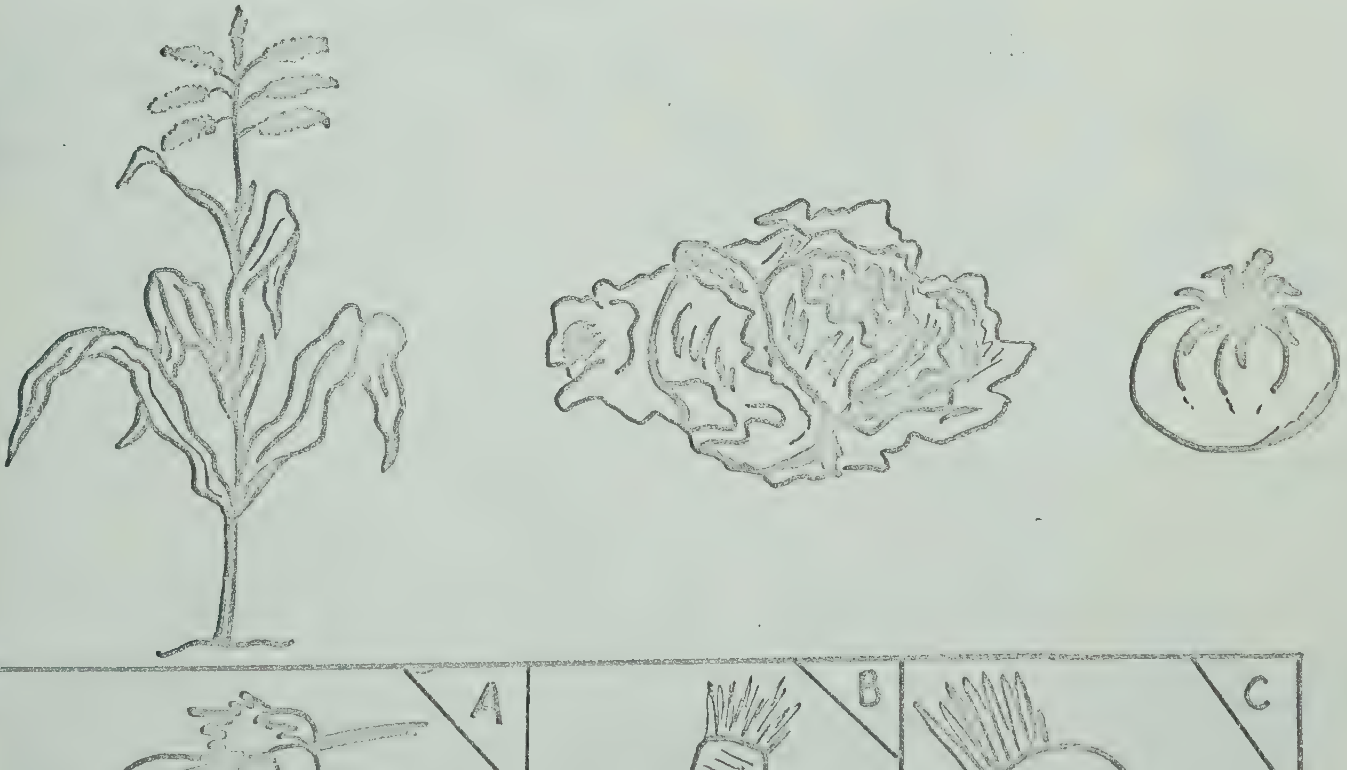

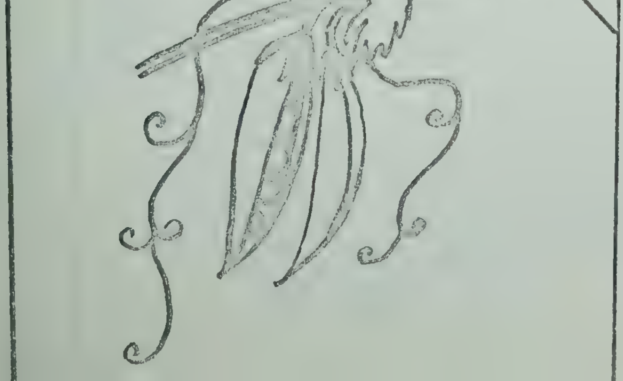

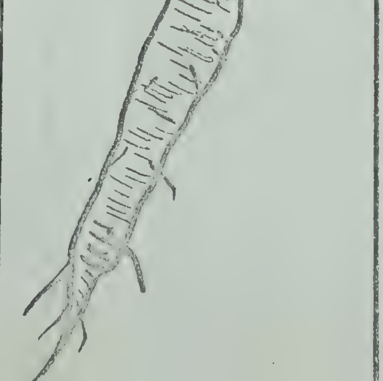

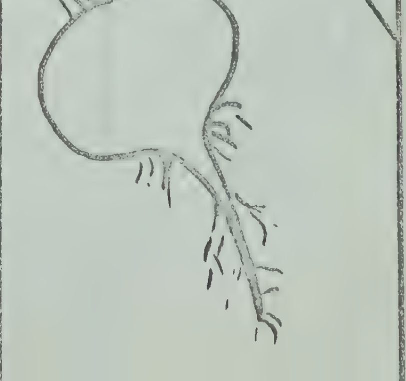

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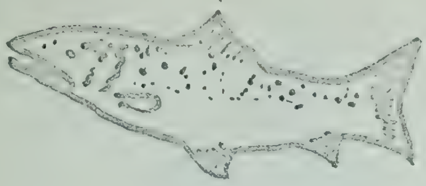

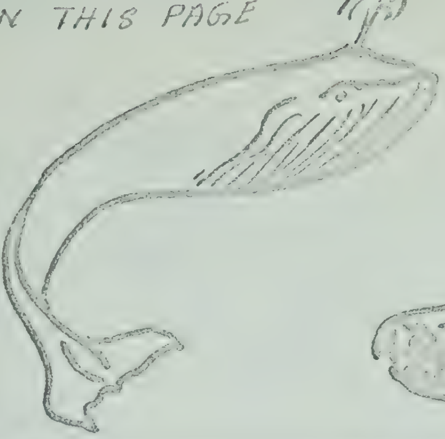

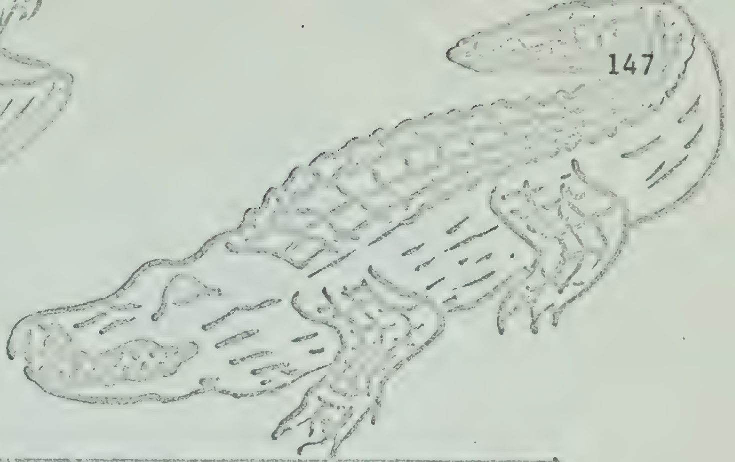

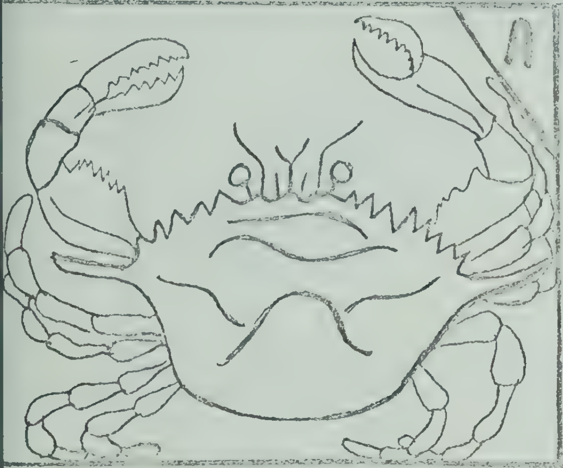

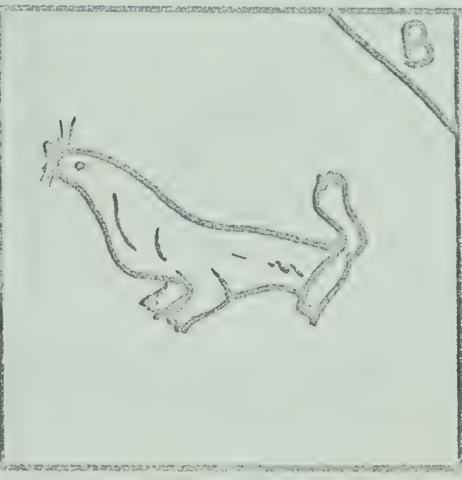

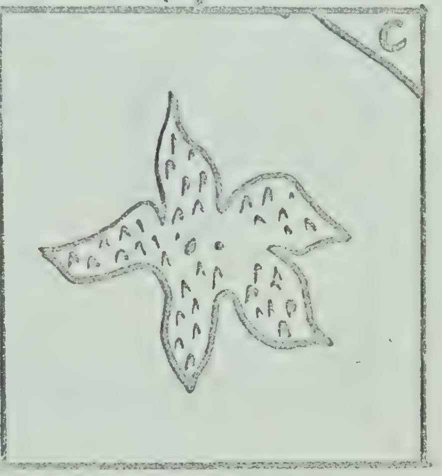

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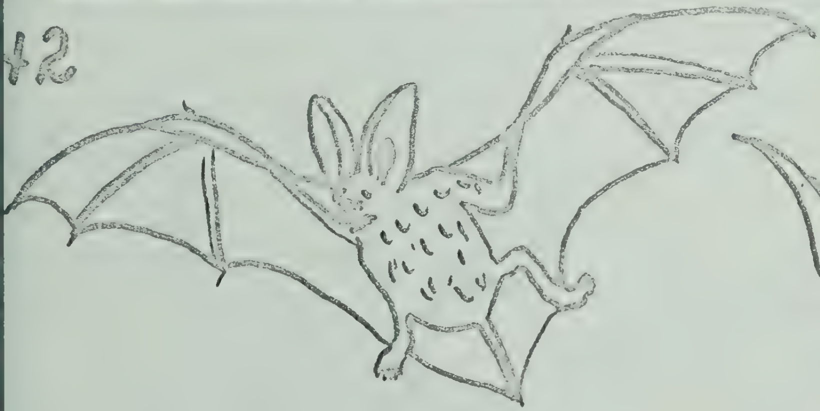

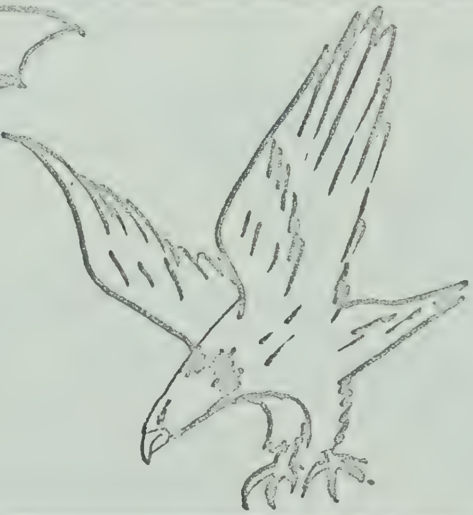

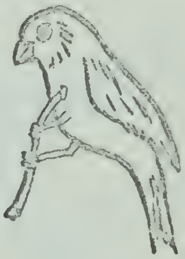

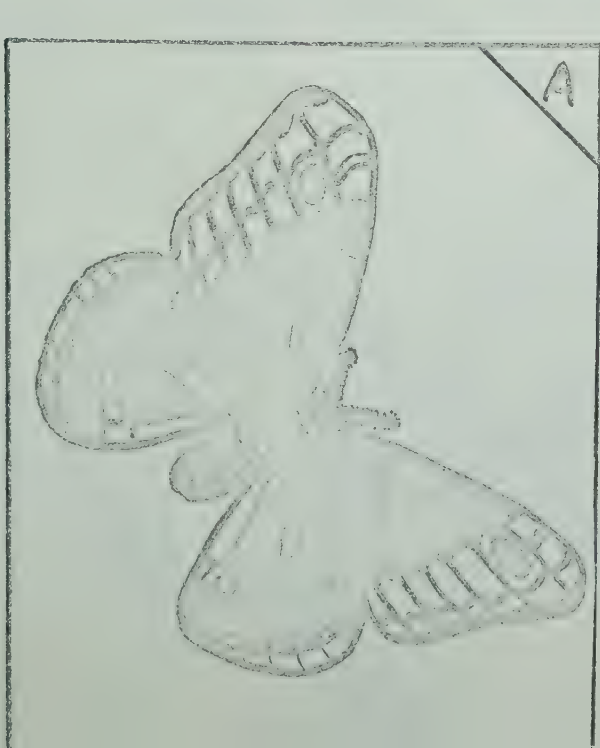

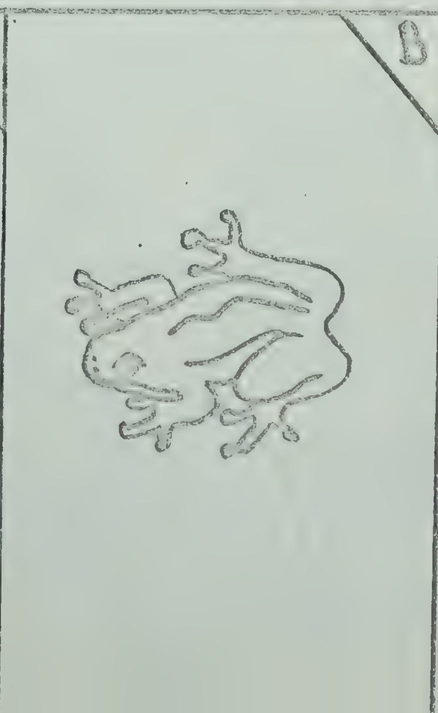

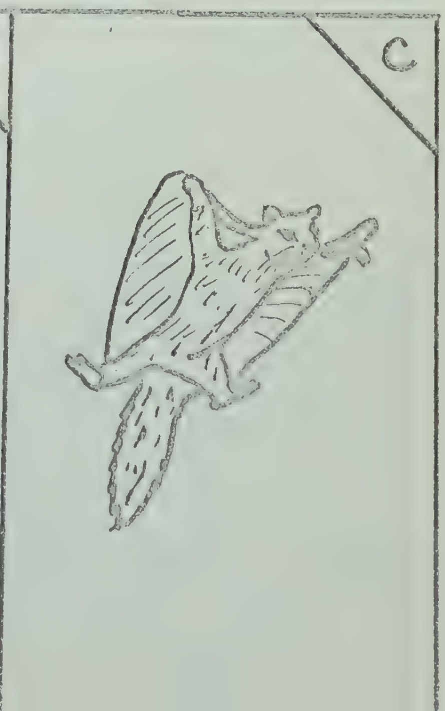

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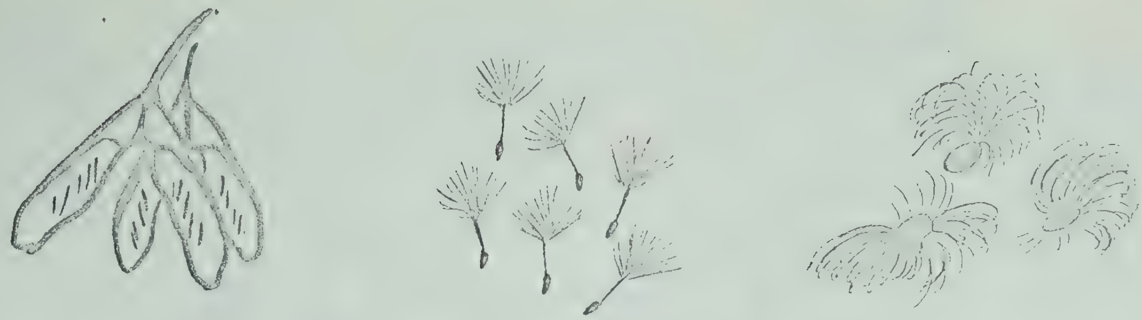

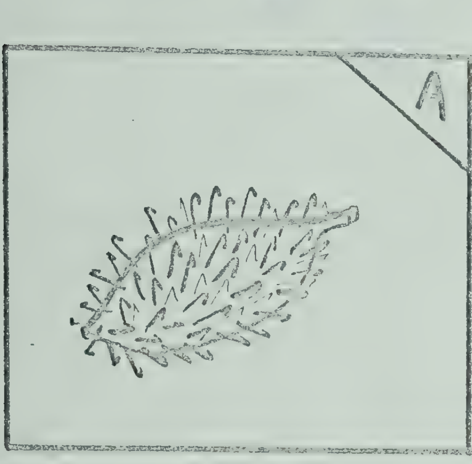

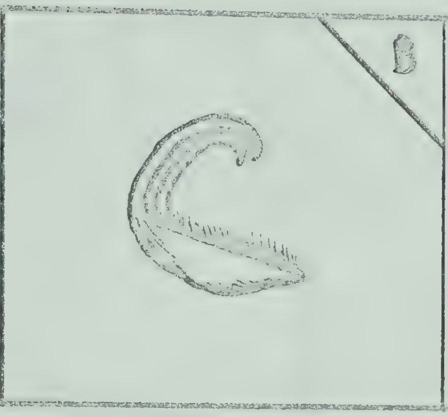

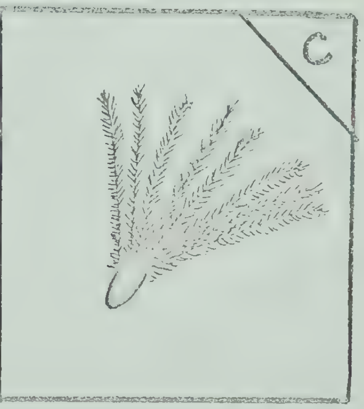

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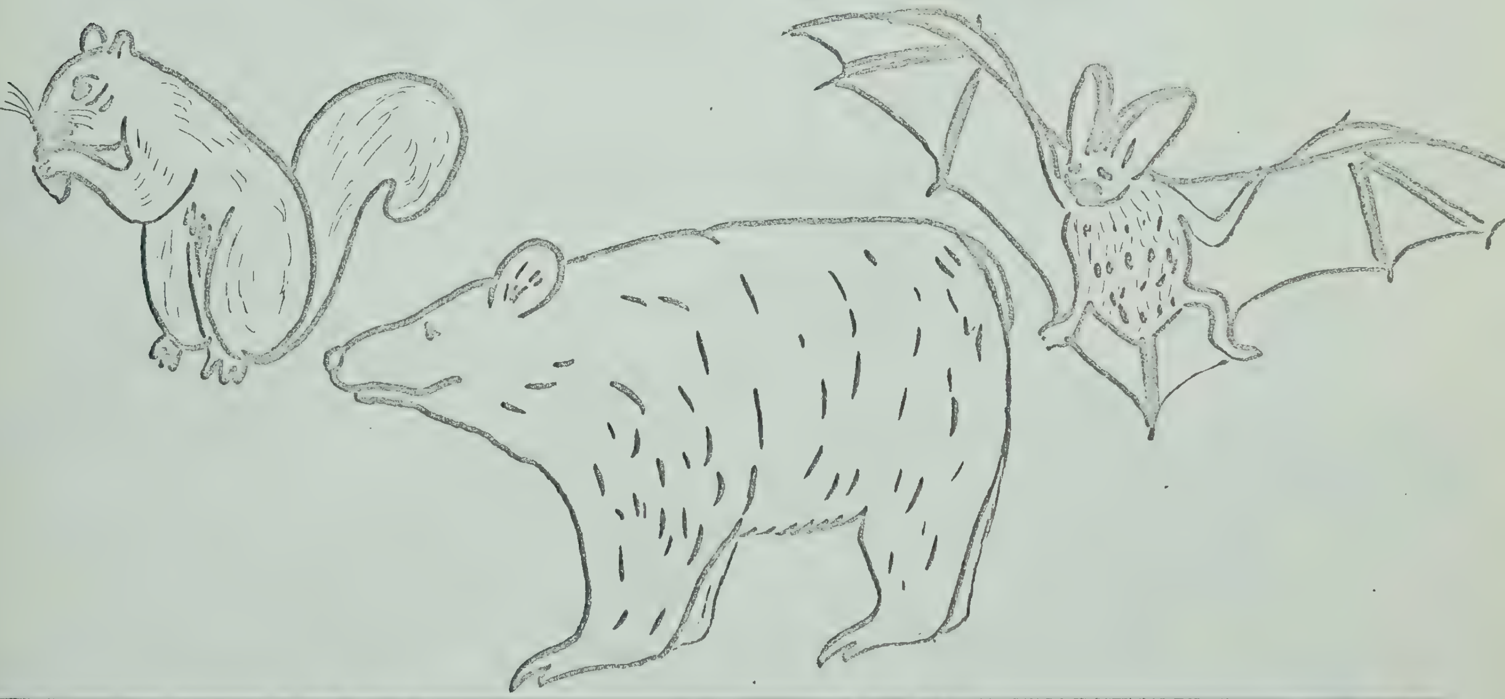

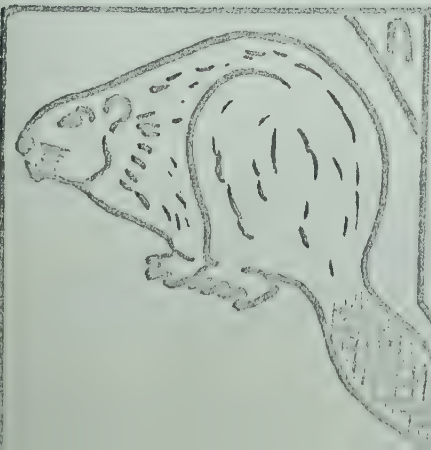

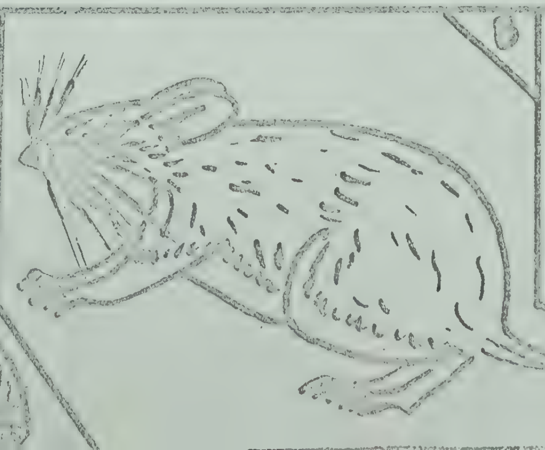

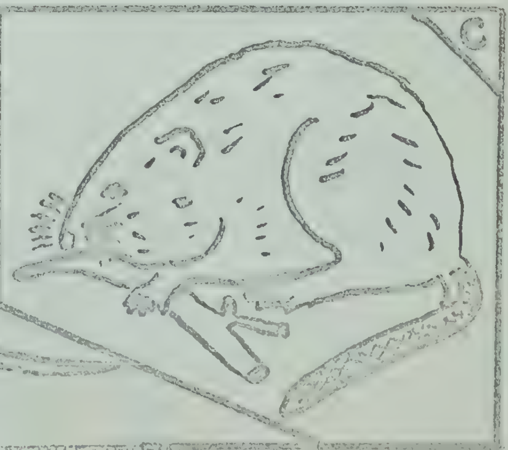

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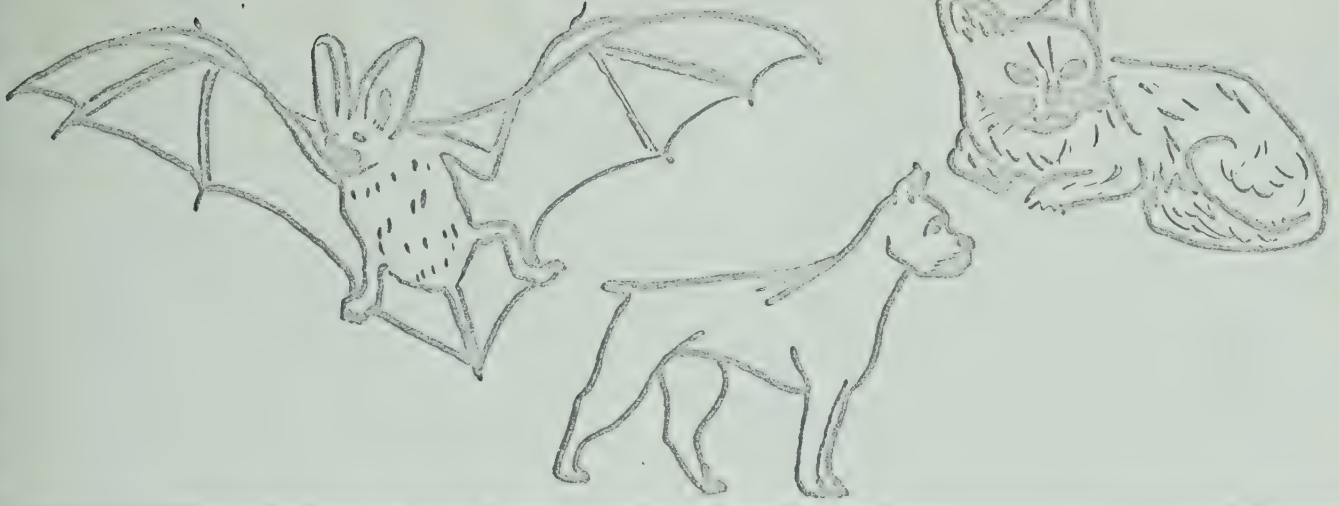

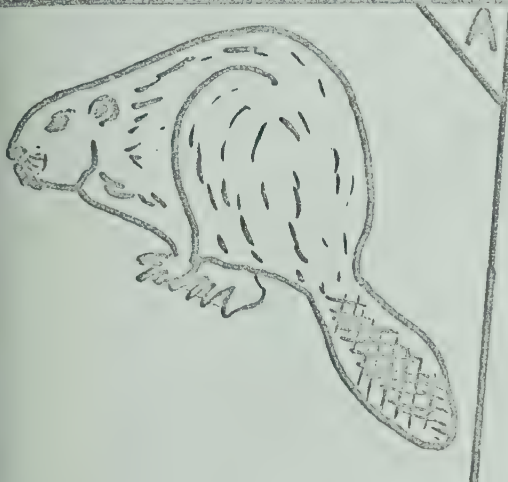

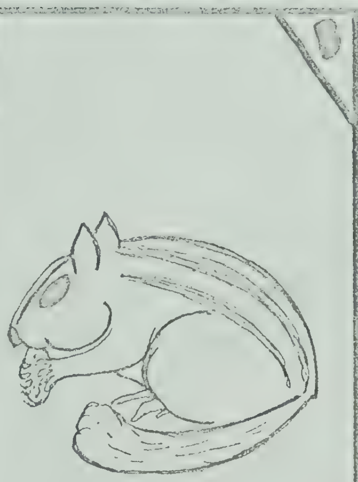

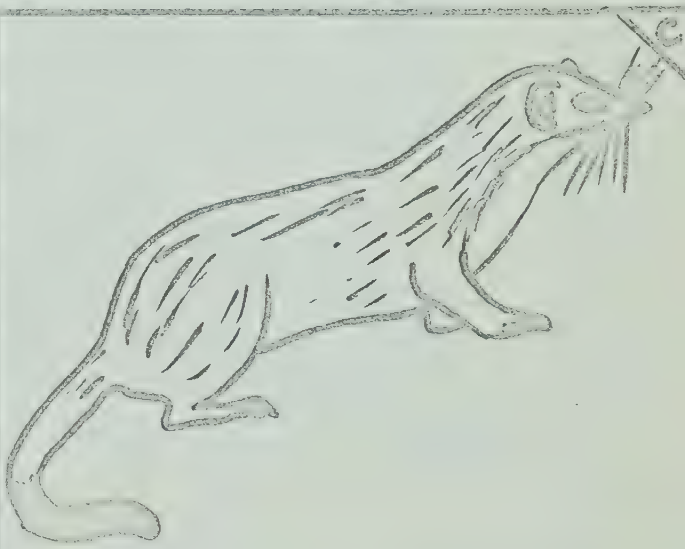

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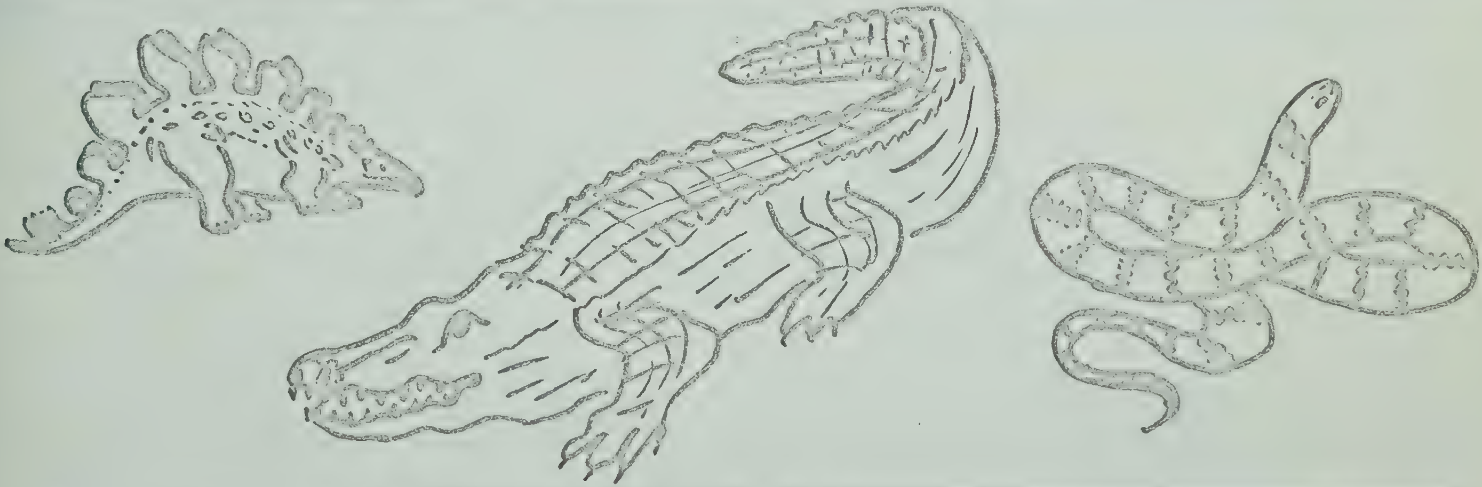

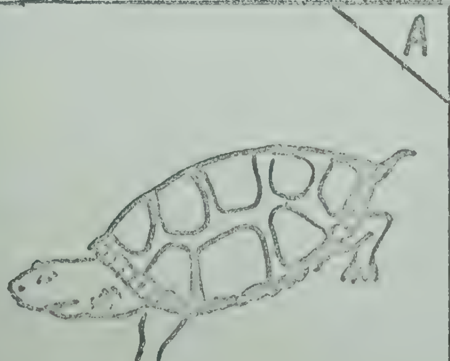

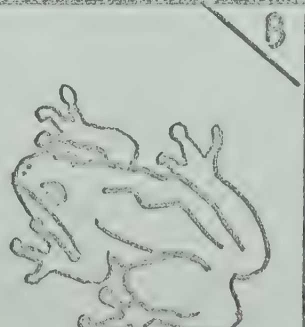

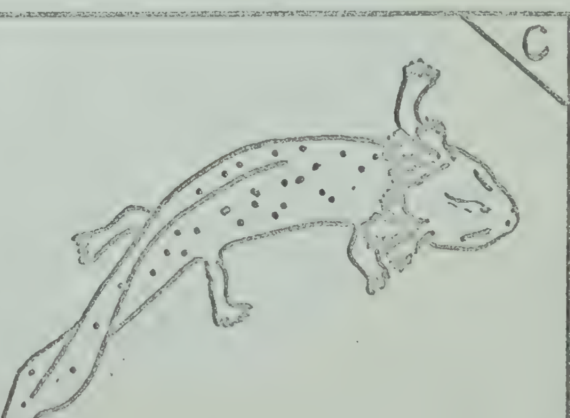

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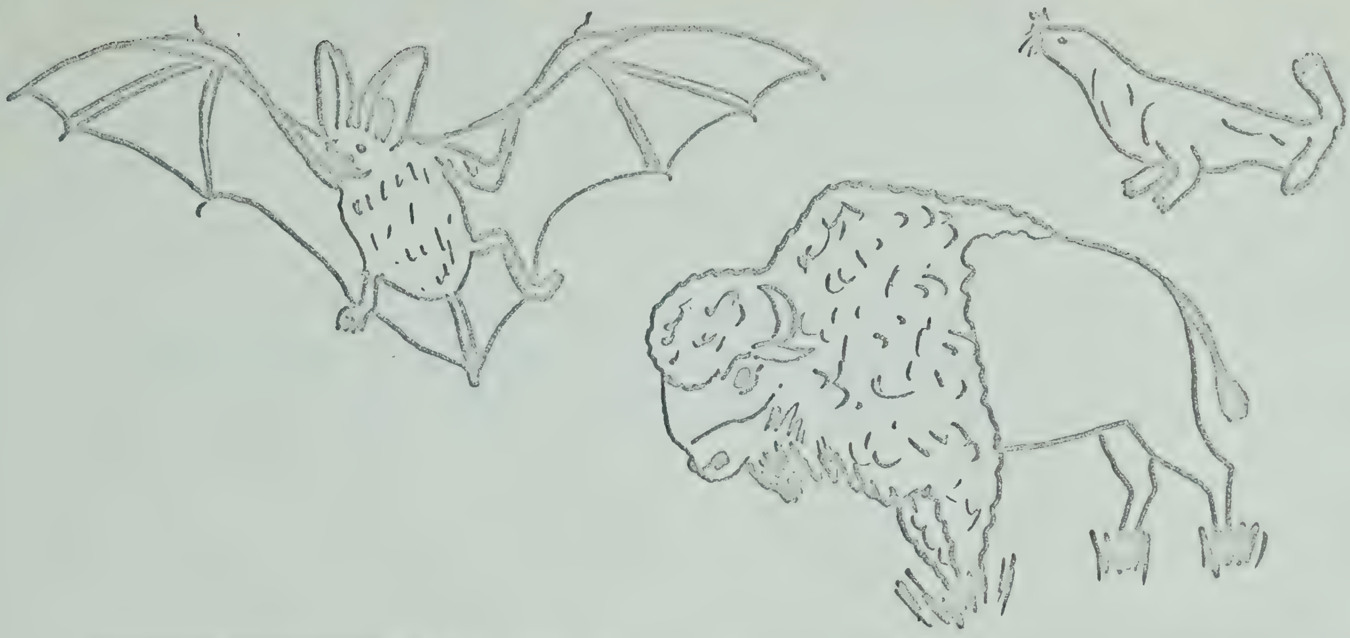

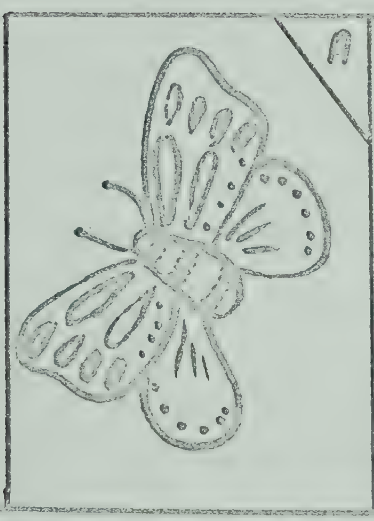

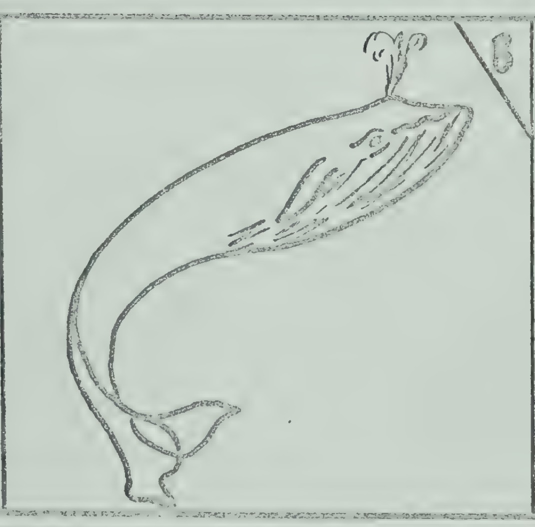

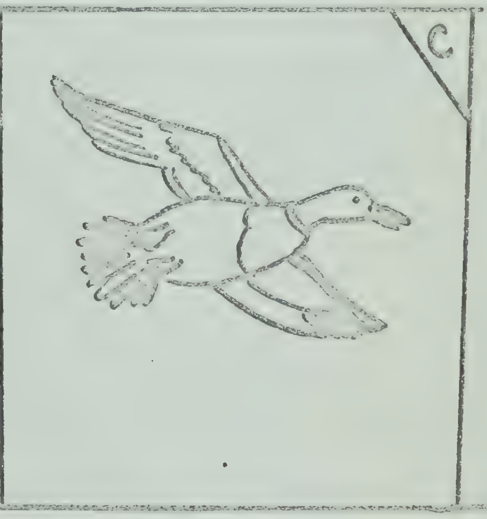

THE END

If you have finished early, you may check your work. Be sure that you have answered every question.

Be sure that any answers you have changed are completely erased on the answer sheet.

READING SCIENCE TEST

SECTION ONE

DO NOT write in any way upon the pages of this booklet. Place your answers on the answer sheet. Start on number one.

You must answer every question. Work as carefully and as quickly as you can.

In each of the following 32 questions, you will be given a problem to solve. It will involve a scientific concept. Only one of the possibilities A, B, or C is the correct solution. On the answer sheet you will see

A 1 B 2 C 3 D 4 E 5 Only spaces A, B or C should ever be marked. Do not put any marks in spaces D or E. If you wish to change an answer you must erase it completely.

EXAMPLE 135. Edmonton is located

A. in southern Alberta near the Saskatchewan border.

B. in central Alberta.

C. in north-western Alberta.

On the answer sheet beside #135, you should have marked B like this B 2

EXAMPLE 136. When attempting to pull a large nail out of a piece of wood, the tool which will give you the best mechanical advantage is

A. a hammer.

B. a pair of pliers.

C. a crowbar.

Which answer did you choose?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

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1. Four small pieces of wax are stuck in a row, onto a long metal rod, and the end of the rod is then heated. Call the piece of wax nearest the heat number one, and the piece farthest, number four.

   A. Wax piece number four will drop off first.

   B. Wax piece number three will drop off first.

   C. Wax piece number one will drop off first.

2. Imagine that you are looking at the side of a water wheel which has a huge water pipe opening above it. The water can flow over the top and down the right-hand side of the wheel, or it can flow down the left-hand side of the wheel.

   A. If the water flows over the top and down the right-hand side of the wheel, the wheel will turn clockwise and counter-clockwise, (in the direction of the hands of a clock and opposite to the hands of a clock).

   B. If the water flows back, over the left-hand side of the wheel, it will turn in a counterclockwise direction, (in the opposite direction from the hands of a clock.).

   C. If the water flows back, over the left-hand side of the wheel, it will turn in a clockwise direction, (in the direction of the hands of a clock).

3. Two weights are suspended by identical metal springs. One weight is 10 pounds and the other weight is 30 pounds.

   A. The 30-pound weight will cause its spring to stretch more than that of the 10-pound weight.

   B. The 10-pound weight will cause its spring to stretch more.

   C. The springs of the 10 and 30-pound weights will stretch the same amount.

4. This problem is about the movement of air over a mountain. Imagine a mountain with masses of air moving toward it from the left-hand side.

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4. A. When clouds of warm dry air move up the west side of the mountain, rain or snow will fall on that side and moist clouds will cross over the mountain.

   B. When clouds of cool dry air move up the west side of the mountain, rain or snow will fall on that side and moist clouds will cross over the mountain.

   C. When clouds of warm moist air move up the west side of the mountain, rain or snow will fall on that side, and dry clouds will cross over the mountain.

5. When a horseshoe magnet is cut in half

   A. the two cut ends both become south poles and the original south becomes a north pole, so that one piece has two north poles, and the other piece has two south poles.

   B. the two cut ends become north and south poles so that one piece has two north poles and the other piece has two south poles.

   C. the two cut ends become north and south poles so that each piece has a north and a south pole, without the original uncut poles changing.

6. Imagine the sun being to your right and the earth situated to your left. As the earth is rotating on its axis, it is turning

   A. from west to east.

   B. from east to west.

   C. from east to west and west to east, alternately.

7. This problem is about the manner in which a flashlight will give light.

   A. When the batteries are attached to each other and to the bulb, and the switch is closed, the bulb will light.

   B. When the batteries are attached to each other, to the case and the bulb, and the switch is closed, the bulb will not light.

   C. When the batteries are attached to each other, to the case and the bulb, and the switch is closed the bulb will light.

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8. This problem is about an object's ability to float.

   A. If an egg is placed in salt water, it will not float.

   B. If an egg is placed in fresh water, it will float.

   C. If an egg is placed in salt water, it will float.

9. This problem is about the direction of movement of car wheels. Imagine that a small car is on your desk, with the front of it facing your left.

   A. If the car moved forward, to the left, the wheels would turn in the direction of the hands of a clock (clockwise).

   B. If the car were to back up, to the right, the wheels would turn in the direction of the hands of a clock (clockwise).

   C. If the car were to back up, to the right, the wheels would turn in the opposite direction from the hands of a clock (counter-clockwise).

10. A frictionless pulley is used for lifting heavy objects.

    A. Using two pulleys, working together, a force of 50 pounds would be needed to lift a 50-pound weight.

    B. Using one pulley, a force of 25 pounds would be needed to lift a 50-pound weight.

    C. Using two pulleys, working together, a force of 25 pounds would be needed to lift a 50-pound weight.

11. When a mixture of sand, salt and water is heated and then poured through filter paper.

    A. water will collect in the dish beneath the filter paper.

    B. sand and water will collect in the dish beneath the filter paper.

    C. salt and water will collect in the dish beneath the filter paper.

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12. A large round glass container had three one-inch-wide holes on the side of it, one near the bottom, one in the middle and one near the top. They were plugged with cork and the container was completely filled with water. Then the corks were pulled out at the same time.

    A. The water sprayed out an equal distance from all three holes.

    B. The water sprayed out the greatest distance from the bottom hole, less from the middle hole and the least distance from the top hole.

    C. The water sprayed out the greatest distance from the top hole, less from the middle hole and the least distance from the bottom hole.

13. Last summer two boxes of equal size and depth were filled with sand and placed in the sun. A thermometer was placed on each box of sand and the bulb of each was pushed into the sand. Box number one was left flat on the ground. Box number two was propped up at a 45° angle. They were left in the noon-day sun for a few hours. When the temperature of each thermometer was checked,

    A. the temperature in box number one was 80°F and in box number two it was 50°F.

    B. the temperature in box number one was 80°F and in box number two it was 80°F.

    C. the temperature in box number one was 50°F and in box number two it was 80°F.

14. A wire from a dry cell battery is wound around a nail several times and then connected to one post of a switch. A wire from the other post of the dry cell is attached to the other post of the switch. Some tacks are available near the nail.

    A. When the switch is closed, the nail will pick up tacks.

    B. When the switch is closed, the nail will not pick up tacks.

    C. When the switch is open, the nail will pick up tacks.

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15. This problem is about the strength of a strong magnet. When the ends of a strong horseshoe magnet are placed against one side of a plate of

    A. glass, and an iron ring is hung a few inches away from the other side of the glass, the magnet can attract the ring through the glass plate.

    B. glass, and an iron ring is hung a few inches from the other side of the glass, the magnet will not be able to attract the ring through the glass plate.

    C. iron, and an iron ring is hund a few inches away from the other side of the iron plate, the magnet will be able to attract the iron ring through the iron plate.

16. This problem is about the flow of an electric current. A dry cell battery has been connected by insulated wires, to a socket with a light bulb in it.

    A. If the two wires are frayed so that the metal wire is exposed, and the two exposed metal parts touch each other, the light will go on.

    B. If the two wires are frayed, but the exposed metal parts do not touch each other, the light will go on.

    C. If the two wires touch each other but are not frayed, the light will not go on.

17. Two wood screws of equal length and width are about to be screwed into a piece of wood. Screw number one has a wide pitch and wide thread and screw number two has a narrow pitch and narrow thread. After they have both been turned around three times,

    A. screw number two will be deeper into the wood.

    B. screw number one will be deeper into the wood.

    C. the screws will both be equally as far into the wood.

18. One wire from a dry cell is connected to a light bulb and then to one end of a

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18. A. piece of paper. When the other wire from the dry cell is connected to the other end of the paper, the bulb will light.

B. nail. When the other wire from the dry cell is connected to the other end of the nail, the bulb will light.

C. piece of glass. When the other wire from the dry cell is connected to the other end of the glass, the bulb will light.

19. Imagine a propeller attached by a rod to a pulley wheel so that both will turn in the same direction. This wheel is attached by a moveable belt, to another pulley wheel. The two pulley wheels will turn in the same direction. A shaft with a rope wound around it in a clockwise direction, is attached to the second pulley wheel. Imagine that the propeller is facing toward you. When the rope is pulled toward the floor,

A. the two pulley wheels will turn in a clockwise direction, and the propeller will turn in a clockwise direction.

B. the two pulley wheels will turn in a counter-clockwise direction, and the propeller will turn in a clockwise direction.

C. the two pulley wheels will turn in a counter-clockwise direction, and the propeller will turn in a counter-clockwise direction.

20. If a test tube three-quarters full of water is solidly corked, and then the bottom is heated until the water boils very rapidly, the cork will

A. pop out of the test tube.

B. be sucked deeper into the test tube.

C. remain in the same position.

21. If small amounts of sand, oil, and salt are poured into hot water,

A. the sand will sink to the bottom, but the oil and salt will float on the top.

B. the oil and salt will sink to the bottom but the sand will float on the top.

C. the sand will sink to the bottom, the salt will dissolve, and the oil will float on the top.

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22. If a small brick is placed in one inch of water, so that it is covered, the water level will

    A. rise to more than one inch.

    B. lower to less than one inch.

    C. remain the same.

23. A glass container, filled with water, has a rubber ball, a nail and a piece of wood lying on the bottom of it. When a magnet is lowered into the container of water, it will be able to attract

    A. the nail and the piece of wood.

    B. none of the objects.

    C. the nail.

24. A wire is strung fairly tightly between two posts. A metal weight is hung from the wire by a string. According to a ruler placed next to the weight the bottom of the weight is three inches above the table top. Now the metal wire is heated by a strong flame. As a result.

    A. the weight will remain three inches above the table.

    B. the weight will move down to about two inches above the table.

    C. the weight will move up to about three and one-half inches above the table.

25. When a solid piece of rock is heated to a very high temperature and then plunged into ice water, it will probably,

    A. remain unchanged in any way.

    B. crumble into a pile of dust and small rock pieces.

    C. develop cracks all over.

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26. When a balloon is blown up very full, outside in the wintertime, and then taken into a very warm room,

A. it will become smaller.

B. it will explode.

C. it will remain unchanged.

27. Two children would like to play together on a teeter totter. One child weighs 50 pounds and the other weighs 100 pounds.

A. When both children sit, one at each end of the board, the small child's end will rest on the ground. The larger child will be held up in the air.

B. When the small child is sitting at the very end of the board and the larger child is sitting halfway along his half of the board, the larger child's end of the board will be resting on the ground.

C. When the small child sits at the very end of the board, and the larger child sits halfway along his half of the board, the board will balance.

28. A bean seed sprouted so that it had a short root and two small green leaves. It had been placed in a closed box on some moist cotton, with the root pointing up and the leaves pointing down.. The front of the box was covered with plate glass so that the plant was easily seen. The box was then placed upright and left for two weeks. After two weeks the seedling was observed and

A. was still growing upside down.

B. the root had turned around and was pointing toward the bottom of the box, while the leaves had turned around and were growing in the direction of the top of the box.

C. the root and the leaves were pointing toward the sides of the box, rather than the top or bottom.

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29. If you pound a magnet several times with a hammer, while it's being heated, it

    A. will still be able to pick up tacks.

    B. will not be able to pick up iron filings.

    C. will be able to pick up more iron filings.

30. A container filled with water has a cork floating on top of the water. An empty glass is inverted over the cork and is then pushed down until it touches the bottom of the large container. As a result

    A. the cork will rest on the bottom of the container and the glass over it will be filled with air.

    B. the glass will fill completely with water and the cork will be at the top of the water, within the glass.

    C. the glass will be filled with water and the cork will rest on the bottom of the container.

31. If one-quarter inch of water is boiled for two hours, the water

    A. will evaporate completely.

    B. level will remain the same.

    C. will increase to almost one-half inch of water.

32. Food coloring, salt, and water are mixed together and then boiled in a closed kettle. The kettle has only one opening. A tube from this opening leads to a container which is sitting in a pan of ice water. Droplets of liquid will be collected in the container. The liquid collected will contain

    A. salt, and water.

    B. water.

    C. food coloring and water.

STOP

DO NOT TURN THIS PAGE UNTIL TOLD TO DO SO

READING SCIENCE TEST

SECTION THREE

Do not write in any way upon the pages of this booklet. Place your answers on the answer sheet the same way you did in Sections one and two. Start on number 33.

In each of the following 15 questions you will find three things at the top which are alike in one main way. At the bottom of each question are three other things, A, B, or C. Only one of A, B, or C could be put with the group above and belongs with them. You are to discover the rule by which the top ones are grouped and then choose one of A, B, or C, and place your answer on the answer sheet.

Example 139. Coconut, potato, pear

A. cotton plant B. walnut C. oak leaves

B. is the answer because the group members and the walnut are all parts of plants, that we eat.
You should mark B like this B 2

on your answer sheet beside 139

Example 140. Dog, cat, horse

A. guinea pig, B. penquin C. beaver

Which answer did you mark on your answer sheet?

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33. bullrushes, kelp, water lily

A. cactus

B. cotton plant

C. pond fern

34. ostrich, eagle, penguin

A. seal

B. bat

C. goose

35. acorn, evergreen seed cone, walnut

A. coconut

B. dandelion seeds

C. cocklebur

36. racoon, flying squirrel, lynx

A. dog

B. sparrow

C. porcupine

37. duckbill platypus, robin, turtle

A. beaver,

B. penguin

C. whale

38. penguin, turtle, dog

A. crab

B. fish

C. duckbill platypus

39. frog, turtle, alligator

A. salamander

B. fish

C. lobster

40. corn, lettuce, tomato

A. peas

B. carrot

C. beet

41. fish, whale, alligator

A. crab

B. seal

C. starfish

42. bat, eagle, sparrow

A. moth

B. frog

C. flying squirrel

43. maple seed, dandelion seeds, milkweed seeds

A. cocklebur seed

B. devil's-claw seed

C. thistle seed

44. squirrel, black bear, bat

A. beaver

B. mouse

C. muskrat

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45. bat, dog, cat

   A. beaver

   B. chipmunk

   C. weasel

46. dinosaur, alligator, snake

   A. turtle

   B. frog

   C. salamander

47. bat, bison, seal

   A. butterfly

   B. whale

   C. duck

STOP - THE END

If you have finished early you may check your work. Be sure that you have answered every question.
Be sure that any answers you have changed are completely erased on the answer sheet.

SUMMARY OF ITEM ANALYSIS (ST. PAUL)

( ) indicates item number on Form 2 (ESSB)

Item No.	Group		Option A	Option B	Option C	Item Difficulty	(Biserial correl.) Item Discrimination
1	Pictorial (P)	High (H)	.13	.03	*.84	.690	.430
		Low (L)	.21	.34	.45		
(6)	Reading (R)	High (H)	.13	.0	.88	.733	.391
		Low (L)	.34	.14	.32		
2	P	H	.25	*.63	.13	.538	.349
		L	.41	.28	.31		
(5)	R	H	.17	.54	.29	.444	.041
		L	.24	.48	.24		
3	P	H	*1.0	.0	.0	.848	.499
		L	.62	.10	.28		
(2)	R	H	.96	.04	.0	.741	.459
		L	.48	.14	.38		
4	P	H	.13	.28	*.59	.552	.076
		L	.24	.31	.45		
(9)	R	H	.04	.25	.71	.452	.360
		L	.14	.55	.31		
5	P	H	.06	.31	*.63	.400	.363
		L	.31	.52	.17		
(8)	R	H	.13	.04	.83	.659	.418
		L	.21	.38	.41		

(* indicates correct answer)

Item No.	Group		Option A	 B	 C	Item Difficulty	(Biserial correl.) Item Discrimination
6	P	H	*.63	.34	.03	.559	.252
		L	.41	.34	.24		
(13)	R	H	.50	.46	.04	.326	.343
		L	.17	.48	.34		
7	P	H	.03	.16	*.81	.676	.335
		L	.14	.41	.45		
(15)	R	H	.13	.29	.58	.304	.437
		L	.10	.83	.07		
8	P	H	.28	.22	*.50	.400	.290
		L	.34	.38	.28		
(7)	R	H	.17	.13	.71	.533	.324
		L	.28	.41	.31		
9	P	H	.06	*.88	.06	.579	.537
		L	.59	.24	.17		
(1)	R	H	.13	.71	.17	.452	.495
		L	.21	.17	.62		
10	P	H	.25	.06	*.69	.462	.322
		L	.31	.38	.31		
(14)	R	H	.04	.29	.67	.570	.288
		L	.38	.24	.38		
11	P	H	.47	.03	*.50	.345	.165
		L	.48	.17	.31		
(11)							

(* indicates correct answer)

Item No.	Group		Option A	Option B	Option C	Item Difficulty	(Biserial Correl.) Item Discrimination
11 (11)	R	H	.38	.04	.58	.407	.240
		L	.28	.38	.34		
12	P	H	.25	*.44	.31	.262	.273
		L	.38	.24	.34		
(12)	R	H	.08	.79	.13	.489	.486
		L	.48	.21	.31		
13	P	H	*.44	.28	.28	.379	.183
		L	.31	.38	.28		
(19)	R	H	.50	.13	.38	.289	.372
		L	.21	.38	.41		
14	P	H	*.97	.0	.03	.738	.452
		L	.48	.0	.45		
(4)	R	H	.75	.04	.21	.311	.482
		L	.17	.34	.48		
15	P	H	*.66	.06	.28	.503	.252
		L	.38	.21	.31		
(20)	R	H	.46	.17	.38	.415	.267
		L	.28	.41	.31		
16	P	H	.0	*.72	.28	.503	.362
		L	.24	.31	.38		
(21)	R	H	.25	.50	.25	.252	.209
		L	.62	.24	.10		

(* indicates correct answer)

Item No.	Group		A	Option B	C	Item Difficulty	(Biserial correl.) Item Discrimination
17	P	H	.03	*.88	.09	.579	.481
		L	.21	.31	.41		
(16)	R	H	.42	.50	.08	.385	.309
		L	.41	.21	.38		
18	P	H	.03	*.97	.0	.883	.413
		L	.07	.69	.17		
(17)	R	H	.0	.96	.04	.793	.402
		L	.14	.62	.24		
19	P	H	*.81	.06	.06	.600	.520
		L	.24	.31	.38		
(10)	R	H	.71	.13	.17	.496	.280
		L	.38	.34	.24		
20	P	H	*1.0	.0	.0	.903	.872
		L	.59	.10	.31		
(24)	R	H	1.0	.0	.0	.889	.365
		L	.79	.07	.14		
21	P	H	.03	.0	*.97	.766	.645
		L	.38	.17	.45		
(26)	R	H	.0	.0	1.0	.793	.530
		L	.34	.14	.52		
22	P	H	*.94	.0	.06	.655	.642
		L	.28	.31	.41		
(27)							

(* indicates correct answer)

Item No.	Group		Option A	B	C	Item Difficulty	(Biserial Correl.) Item Discrimination
22 (27)	R	H	.88	.08	.04	.756	.394
		L	.48	.17	.34		
23	P	H	.0	.09	*.91	.772	.550
		L	.10	.45	.45		
(22)	R	H	.04	.08	.88	.726	.415
		L	.10	.41	.48		
24	P	H	.13	*.88	.0	.759	.397
		L	.41	.48	.10		
(32)	R	H	.04	.67	.29	.541	.228
		L	.07	.45	.48		
25	P	H	.13	.09	*.78	.448	.444
		L	.48	.24	.28		
(29)	R	H	.04	.13	.83	.644	.310
		L	.34	.21	.45		
26	P	H	.03	*.75	.22	.690	.123
		L	.07	.62	.31		
(35)	R	H	.17	.79	.04	.630	.277
		L	.41	.52	.07		
27	P	H	.03	.06	*.91	.724	.372
		L	.10	.34	.55		
(30)	R	H	.0	.08	.92	.644	.515
		L	.24	.38	.38		

(* indicates correct answer)

Item No.	Group		A	Option B	C	Item Difficulty	(Biserial Correl.) Item Discrimination
28	P	H	.03	*.91	.06	.586	.357
		L	.34	.45	.21		
(34)	R	H	.17	.63	.21	.622	.273
		L	.14	.41	.41		
29	P	H	.22	*.44	.34	.221	.397
		L	.31	.07	.62		
(23)	R	H	.21	.71	.08	.422	.290
		L	.24	.45	.31		
30	P	H	*.66	.34	.0	.331	.494
		L	.10	.72	.17		
(31)	R	H	.58	.25	.17	.281	.422
		L	.10	.52	.38		
31	P	H	*.88	.06	.06	.634	.432
		L	.41	.24	.34		
(28)	R	H	.88	.08	.04	.763	.361
		L	.55	.21	.21		
32	P	H	.16	*.47	.38	.338	.186
		L	.14	.28	.59		
(33)	R	H	.08	.38	.54	.259	.050
		L	.24	.24	.48		
33	P	H	.03	.03	*.94	.917	.425
(37)		L	.14	.07	.79		

(* indicates correct answer)

Item No.	Group			Option		Item Difficulty	(Biserial correl.) Item Discrimination
			A	B	C		
33 (37)	R	H	.08	.0	.92	.756	.503
		L	.21	.21	.55		
34	P	H	.0	.25	*.75	.683	.300
		L	.24	.28	.48		
(36)	R	H	.04	.0	.96	.719	.466
		L	.34	.21	.45		
35	P	H	*.78	.16	.06	.821	.106
		L	.72	.14	.14		
(39)	R	H	.50	.46	.04	.474	.179
		L	.38	.38	.24		
36	P	H	.13	.13	*.75	.566	.426
		L	.24	.41	.34		
(40)	R	H	.13	.0	.88	.630	.321
		L	.31	.28	.41		
37	P	H	.13	*.75	.13	.448	.401
		L	.41	.31	.28		
(44)	R	H	.13	.83	.04	.615	.218
		L	.28	.62	.10		
38	P	H	.09	.13	*.78	.690	.306
		L	.17	.31	.52		
(47)	R	H	.13	.13	.75	.741	.177
		L	.21	.17	.62		

(* indicates correct answer)

				Option			
Item No.	Group		A	B	C	Item Difficulty	(Biserial Correl.) Item Discrimination
39	P	H	*.78	.13	.09	.655	.328
		L	.41	.45	.14		
(49)	R	H	.88	.08	.04	.593	.381
		L	.41	.28	.31		
40	P	H	*.94	.03	.03	.745	.288
		L	.66	.10	.24		
(50)	R	H	.67	.25	.08	.533	.300
		L	.38	.41	.21		
41	P	H	.13	*.69	.19	.434	.231
		L	.21	.41	.38		
(41)	R	H	.21	.67	.13	.630	.270
		L	.34	.34	.31		
42	P	H	*.69	.03	.28	.497	.338
		L	.31	.17	.52		
(45)	R	H	.46	.0	.54	.348	.138
		L	.31	.10	.59		
43	P	H	.16	.09	*.75	.690	.271
		L	.17	.28	.55		
(51)	R	H	.08	.13	.79	.533	.454
		L	.41	.28	.31		
44	P	H	.31	*.47	.22	.559	.076
(52)		L	.31	.48	.21		

(* indicates correct answer)

				Option		Item	(Biserial correl.)
Item No.	Group		A	B	C	Difficulty	Item Discrimination
44 (52)	R	H	.17	.58	.25	.400	.309
		L	.21	.34	.45		
45	P	H	.06	.47	*.47	.366	.144
		L	.14	.59	.28		
(43)	R	H	.25	.42	.33	.281	.143
		L	.07	.69	.24		
46	P	H	*.50	.03	.47	.276	.433
		L	.14	.41	.45		
(38)	R	H	.63	.13	.25	.319	.278
		L	.24	.14	.62		
47	P	H	.16	*.59	.25	.438	.128
		L	.14	.41	.45		
(46)	R	H	.04	.67	.29	.526	.112
		L	.10	.48	.41		

(* indicates correct answer)

APPENDIX D

TEACHER OPINION (ST. PAUL)

Teacher	Opinion	
	Specific	General
A.	Both tests are far too difficult.	
B.	(R) #3 - Too obvious #19 - a bit confusing (P) #7 - switch off or on may be hard to decipher #9 - arrows may be mistaken for (car air) movement - as a result both A or C could be correct #19 - arrows may be confusing and be disregarded as important	1."Vocabulary is appropriate for grade level." 2."Some questions are somewhat difficult for grade 6 considering the background they've had".
C.	(RST) #5 - too easy for grade 6 #14 - rather too easy #19 - confusing - better in picture form #20 - easy, but if pupils had no experience with this it would make a good hypothesis type #25 - grade 5 level for weathering concept #31 - too easy, by this grade level pupils know that water evaporates. Rather poor multiple choice question	"It was felt by the pupils that the pictorial type was much easier than the reading type. However, I personally think that the reading science test was good because pupils had to interpret in their minds what they read." Last section of plants and animals - Good
D.	(RST) #2 - too long & wordy #4 - too long, indefinite #5 - answer too long #8 - good #9 - too indefinite #12,#13 - too long #19 - too long, confusing	Questions tested general but did not follow new science curriculum.

Teacher	Opinion	
	Specific	General
D.	(PST) #2 - confusing, too many arrows #6, #7, #9, #19 - confusing #24, #43 - confusing	

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